THE

PROCESSES OF PURE PHOTOGRAPHY,

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PREFACE.

Of the two writers, both have zealously followed photography as something more than a mere amusement, for a considerable number of years. One of the writers has studied the science from a theoretical and experimental point, while the other writer's attention has been almost entirely directed to the production of practical results by the processes known, and by each process as it has been given to the world. As joint authors, therefore, we trust that our joint work may be acceptable to the photographic public; not as replacing, or superior to, other works, but rather as filling a place not occupied by any other work. The chief claim made for our work is that every word we have written in it refers to subjects with which we are personally and intimately acquainted; not a direction nor a formula is given on trust, every one has been successfully used by one or other of us, in most cases we have both used the formulæ found in this book.

At first our MSS. extended to a very considerable length, and treated photography completely as theoretical, practical, and artistic; but circumstances caused us to abridge our work, and to produce a book less complete, and, perhaps, less interesting, but, as we hope, more generally useful, not only to amateurs and beginners, but also to those who desire authentic instructions and formula for every-day work. Such instructions and formulæ, tested carefully by ourselves, and likely to be useful to our readers, it has been our ambition to give the public. Whether or not our aspirations have been fulfilled, each member of the public may judge for himself, by application (suitably accompanied) to the publishers of our little book!

W. K. B.
A. P.

CONTENTS.

The Processes of Pure Photography.

CHAPTER I.

INTRODUCTORY AND HISTORICAL.

Photography is one of the greatest *facts* of the present day. Its influence is of very wide scope, because it is not only an almost infallible means of recording *facts*, but also a simple means whereby the artistically inclined may, to a certain extent, find expression for their *fancy*. Photography not only affords us evidence of what we, and nature, appear, but enables us to depict, within limits, what we, and the rest of nature, might be. Briefly, photography is at once a science and an art. Without a certain knowledge of the science, we cannot produce any effect at all, artistic or otherwise; but we may master the science, stop there, and still have in our hands a most potent agent for depicting, graphically, *facts*. Again, if our ultimate object be to use photography as an art, we must master the science, first of all, that we may be able to produce a graphic result, and next, that we may control our result, so that our scientific means may lend themselves to our artistic aspirations; and the more control over, and facility in, our scientific operations we have, the more fully shall we be able to give our minds to the realization of our artistic conceptions.

In the same way, if our ultimate object be purely scientific, if our sole ambition is to give true photographic copies of what

we see, especially if we see it under difficulties, such as those of great magnification, or reduction in size, we must still master our photographic science, so that the combined difficulties of seeing and depicting what we see may not overpower and conquer us.

In this book we do not propose to deal with art, nor with any science except purely photographic science; and our aim is to lay bare, as clearly as space will permit us, the principles regulating, and the practices most suitable for, successful photography. We are prevented by circumstances from fully entering into the theories, or touching on more than very few of the practices which control successful photography, but it is our ambition to so lay down the practice that close elucidation of the theories will not be essential to the intelligent reader, or, at least, so that the reader may, while acquiring the power of producing photographs, be only tickled, and not driven to study the theories.

On the above basis it is clearly unnecessary for us to give more than a cursory *résumé* of the chief results that mark the history of photography. The great landmarks are those following. We can attach no date to the first observation of light action on silver chloride, but to do so we should have to go back at least 300 years. That different parts of the solar spectrum affected silver chloride in different ways was observed by Ritter and Seebeck, in 1801 and 1810. Wedgewood and Davey observed more energetic light action on the silver salt on a basis of white leather than on paper. This contained the germ of *development* processes acting by *reduction* of the silver salt, the tannin of the leather playing the important part.

Camera photography may be attributed to Joseph Nicephore de Niépce, who gave the first authentic account of it. He used bitumen spread on a metal plate. Bitumen, on exposure to light, loses its pristine solubility in certain oils. With de Niépce, Daguerre, a miniature portrait painter, in 1829, entered into partnership; in 1839 the Daguerreotype process was announced. Between these dates Niépce had died, and whatever share of the credit was due to him Daguerre claimed the whole of it, and attached his name to the process. Then fol-

lowed the addition to the silver iodide of Niépce, of silver bromide, by Goddard, in 1840; also, in 1840, Sir J. Herschell added an important step to the progress, discovering the solubility of silver salts in sodic hyposulphite, so that a method was no longer wanting to *fix* the image. This sodic salt is an important item in the photographic laboratory of the present day.

In 1839—that eventful year for photography—Fox Talbot published his first process, wherein he coated paper with sodic chloride, and thereafter brushed over it silver nitrate, thereby forming silver chloride in presence of excess of silver nitrate, the basis, with the addition of albumen, also suggested by Talbot, of our "silver printing" process of to-day

Talbot again comes to the front with an enormous stride in his negative process, whereby, in place of one positive picture being the *ultimatum* of a whole set of operations, we produce by one set of operations a negative, forming a *matrix* for a theoretically unlimited number of positive pictures. (See chapter on Positive and Negative, p. 34). This process, which Talbot called "calotype," was a development process, the reagents being silver nitrate and gallic acid, the latter due to the Rev. J. B. Reade.

About 1850, Le Gray seems to have suggested the use of collodion as a "vehicle" for the sensitive silver salts; Scott Archer certainly published the first collodion process. It is worthy of note, however, that the lately deceased Mr. J. G. Tunny, of Edinburgh, has stated in our hearing, that Le Gray furnished him with a good practical collodion process before Archer's was published; and, further, that he (Mr. Tunny) used Le Gray's process in conjunction with the "iron developer."

For many years, and with great reason, the wet-collodion process reigned supreme; but, grand as its qualities were, it had the drawback that the plates had to be used wet, and a great load of paraphernalia had to be carried afield for the work. The advent of dry-collodion processes was felt, as a matter of convenience at least, to be a marked advance. The free silver nitrate of the wet process was replaced by other

iodine absorbents of organic nature, and photographers "ran riot" among such substances as beer, tea, coffee, tannin, beef-tea, tobacco—and who knows what besides!

The discovery, in 1862, of the alkaline developer gave a great "fillip" to dry processes, for by it not only the free silver nitrate on the film is reduced, but also the silver haloids in the film.

The bath was dispensed with, at last, in favor of emulsion processes, the joint invention of Messrs. B. J. Sayce and W. B. Bolton, both of whom are to be credited with the advance. Finally, gelatine replaced collodion, the first published gelatine emulsion process being that of Dr. R. L. Maddox, in 1871. In 1874, Mr. R. Kennett made gelatine pellicle, and, in 1878, gelatine began to leave all other "vehicles" behind it. In this year, 1878, in March, Mr. Charles Bennett published his process, whereby he produced gelatino-bromide emulsion of a sensitiveness that utterly overshadowed all previous preparations; this he achieved by prolonged digestion of the emulsion at medium temperature. Mr. Bolton is again heard of in his suggestion to gain sensitiveness by short boiling in presence of a minimum of gelatine in place of long digestion with the full bulk of gelatine. The only really important modification since that was the ammonio-nitrate process, of which full details will be found in our chapter dealing with the subject.

In development, since the "alkaline developer" was published, we have to record no striking variation, save the ferrous oxalate developer of Messrs. Carey Lea and W. Willis. Mr. Lea's process was first published, but we are able to state that Mr. Willis' memorandum of the process was in the hands of the editor of a periodical three months before Mr. Lea's process was published, accident only depriving Mr. Willis of the credit.

The advances in printing processes have been of no less importance than those in negative processes. For a long time the production of prints more stable than those formed from silver chloride on paper was a problem, but the discovery by Mungo Ponton, in 1838, of the sensitiveness to light of potassic bichromate in presence of certain organic substances, led

up after a course of experiments by Becquerel, Poitevin, Pouncey, and others, to the publication, by Swan, of the "carbon" or "pigment" printing process, certainly the first that could go under the name of "permanent."

Out of certain other qualities of chromates, in presence of organic matter, arose a long series of photo-mechanical processes with which we cannot here deal.

The platinotype process, treated later by us, is due to Mr. W. Willis.

The latest advances in photography are connected with "orthochromatics" or color correct photography, and in this field the labors of Vogel, Ives, Eder, Schumann, and Bothamley are conspicuous.

To those interested in the historical development of photography, we recommend the "History of Photography," by W. J. Harrison.

CHAPTER II.

THE THEORIES OF PHOTOGRAPHY.

Light is supposed to consist of, or to be produced by, waves of a substance known as ether, all-pervading and imponderable. Light is merely the name by which we call the sensation produced upon our senses by these ether waves.

Matter is supposed to consist of *atoms*, particles so infinitesimally small as to be incapable of division and in constant motion among each other. "Molecule" is the name we give to an aggregation of two or more atoms of different kinds in combination.

The waves constituting light are not all equal in length from crest to crest, nor do they travel from their source at equal paces. Some light waves are very much shorter than others, and, moreover, when in their course they pass from a medium of one density into a medium of another density, some waves or "rays" are turned out of their course ("refracted") more than others. The rays formed by short waves are turned out of their course more than the rays formed by longer waves. A ray of white light is composed of a vast number of waves of different lengths and different "refrangibilities," and, moreover, at each extremity of the scale of visible wave-lengths are rays which our eye cannot appreciate, just as in sound there are waves so frequent and others so distant from each other that our ear fails to record them to our brain.

The visible light rays which are shortest from crest to crest, and which are the most "refracted" on changing the medium through which they travel, convey to our mind the sensations of what we call blue or violet colors. Still shorter and still more refrangible are many rays invisible to us. These short,

highly refrangible, visible rays, and the still shorter and more refrangible invisible rays are remarkable for the energy with which they exert chemical action, and to the chemical action exerted by these rays specially we owe the power of producing a photographic image. The usually accepted theory is that the wave length of these chemical rays is of such a "measure" as to produce vibration synchronous with the vibrations already mentioned as taking place among atoms, and so either causing entire severance between the atoms forming a molecule, or else placing these atoms in such a condition that the severance is ready to take place when suitable steps are taken or conditions observed to complete the inchoate process of separation. In photography with silver salts the molecule consists of an atom of silver and an atom or atoms of some other substance, photographic action consisting in this case of a severance between the silver atom and the other atom.

If all the rays composing visible light exerted anything like an equal amount of chemical activity, it is evident that photographic action might take place and yet be totally useless to us, because uncontrollable by us; for in that case we should be unable to see any of our processes. But it so happens that while we have some of the rays composing white light exerting strong chemical action, we have other rays of much greater wave-length and much less refrangibility marked by much inferior chemical energy, though their wave-lengths are still great enough for our eye to appreciate. These rays which produce on our mind, tutored by our eyes, the sensations of orange and red colors are called "heat rays," and beyond the scale of visible heat rays there are other rays even longer and even less refrangible, and possessing even less chemical energy than the visible red rays. So that while we can use the "chemical rays" of light to obtain photographic action, we can use the "heat rays" to enable us to see sufficiently well to manipulate our photographic materials while we prepare our "sensitive" substances, and while we complete the processes started by the chemical agency of light, referred to by us as "inchoate," but ready to be completed under certain conditions.

In short, by a non-chemical or "non-actinic" light, we prepare our sensitive material; to chemical action of light we expose it, and by non-actinic light we "develop" the action started by the light; a "sensitive" material being one capable of being acted upon by light.

There are other rays forming components of white light intermediate between the heat rays and chemical rays, in points of wave length and refrangibility. These intermediate rays have a speciality of their own, viz., visual brightness, and we call them "yellow" or "green." The yellow is not so much endowed with heat characteristics as the red rays, nor is the green so remarkable for chemical activity as the violet rays; but all the component parts of a ray of white light have a certain amount of chemical power, and a certain amount of heating power, just as all the visible component rays of white light have a certain amount of visual brightness.

If an opaque object appears to us "red," it appears so in virtue of its *absorbing* the other rays and *reflecting* to our eyes red alone. If a sheet of glass were stained really and purely red, no visible rays would pass through it except red. An opaque object "reflects," a transparent object "transmits," light; but, so far as color is concerned, the theory holds good for reflection as for transmission. A beam of white light caused to change its course by being passed out of one medium through another of different density in a certain simple manner, may be analyzed or broken up into its component rays, so that these rays can be distinguished ocularly from each other from their different colors and by the different directions in which they travel after "refraction," and an instrument made for the purpose of facilitating the observation of these differentiations is called a spectroscope, the analyzed or separated and colored band of rays being called a "spectrum."

The science of optics depends, equally with the science of photographic chemistry, on these qualities of light, and while the refraction *per se* is the action most useful in optics, the coloring dependent on the "bending" is a factor that requires to be carefully minimized or totally counteracted.

The chief processes of photography depend on what is called

"reduction." We start with a compound of (say) silver and something else. Actinic light either "reduces," or prepares for "reduction," our compound, and the "reduction" consists in removing the something else, and leaving the silver alone to form the visible photographic image.

The optics of photography are directed chiefly to regulating the size of our image, light unaided is quite able to effect all our purposes, but without the aid of optical appliances light would be for us an unmanageable and unprofitable servant.

We do not expect, and still less wish, this summary to be taken as touching more than the extreme outskirts of the subject of photographic theory. We believe that a thorough mastery of the whole theory is almost essential to a thorough mastery over the practice, but our limits absolutely preclude other explanation.

Certain processes are not even touched by the above remarks; on encountering these processes in their turn, we shall say a word or two on the special theories regulating them.

CHAPTER III.

APPARATUS.

THE apparatus required for the production of a photograph, by the usual processes, may be summed up under two heads: 1st. Apparatus for producing a negative, or a direct positive. 2d. Apparatus for producing prints from a negative.

The apparatus required essentially for the production of a negative are, a camera, a lens, and an apartment, or box, illuminated by a non-actinic light. (A lens is not absolutely necessary, but is almost always used). For convenience we require a support for the camera, and vessels of suitable size and shape for chemical operations.

Cameras are merely light-tight boxes for preventing light, other than that passing through the lens, from reaching the sensitive plate, and cameras further afford a means of varying the distance between the lens and the sensitive surface, so that the plate may be placed at one focus of the lens. As ocular examination is required to enable us accurately to place the plate in that focus, the camera is provided with a piece of ground-glass representing the sensitive plate in position, while the plate itself is securely carried in a light-tight receptacle, known as a "dark-slide," or "carrier," until the light is to act upon it in the camera, at which juncture a shutter is removed from the slide or carrier *in situ* in the camera, so that the light from the lens reaches the plate, while no other light can reach it. Evidently the sensitive plate, when undergoing light-action, must in position coincide accurately with the position occupied by the ground-glass, while we were placing the ground-glass in the focus of the lens. This coincidence of position between ground-glass and sensitive plate is known as "register."

As a matter of convenience and efficiency, cameras are made in two types, a camera for outdoor work, and a camera for studio or indoor operations. The studio camera, not requiring to be carried about, should be of strong material, and should have every mechanical convenience without respect to weight. The "outdoor," "landscape" or "tourist's" camera should have every mechanical motion, and be made of the strongest material consistent with portability.

Certain conveniences should be found in every camera, irrespective of weight, and certain qualities are essential to every camera, irrespective of all other considerations. A sufficient amount of stretch, sufficient strength, and complete rigidity are essentials to every camera. In studio cameras these qualities are usually present; in tourist cameras they are frequently neglected in the mania for lightness.

A camera, for perfect efficiency, should have a front so made that the lens, the flange of which is attached to the front, may be moved up and down, at least, and across, if possible, parallel to the sensitive surface. It is frequently convenient, for certain reasons, to be able to put the sensitive surface out of perpendicularity to the axis of the lens; and it is frequently convenient, while tipping the lens upwards, to preserve the parallelism of the sensitive surface with the plane of sight, or with upright objects in the view. These desirable qualities are obtained by what is known as a "swingback."

Time and temper are sometimes lost when, on an oblong plate, the view has to be taken with the plate in the vertical position instead of the more usual horizontal. If the camera be not unscrewed from its bearings on the stand and placed bodily in the desired position, a "reversing back" is required, and it is certainly a great convenience. The camera-body has to be made square for a reversing back to be permissible, but the extra weight and expense entailed are usually made up for by the extra convenience.

To save weight, the greater portion of camera-body is usually made of leather, in the form of bellows; and to save bulk, the bellows are often made to taper more or less towards the front. This taper is convenient, but must not be too sud-

den or carried to too small a point, otherwise the bellows may interfere with the image.

In some tourist cameras the stretching operation is effected upon the front, in others upon the back of the camera. Each system has its advantages, and each its disadvantages. If the front part of the base-board projects too far in front of the lens, there is, at certain times, a danger of the projecting front trespassing on the field of the lens. We figure a camera of

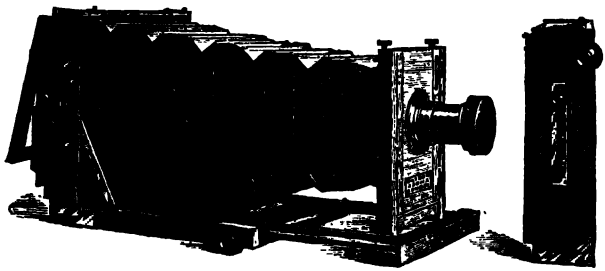

FIG. 1.

each of the types in general demand, No. 1 being a tourist camera, No. 2 a studio camera. It is not within our province minutely to describe any special camera; we have suggested what we consider the essentials of a good camera. The purchaser must rely upon the honesty of the parties with whom he deals. Our remarks are only intended to prime the tyro, so that when he goes to make a purchase he may have at least a faint idea of what he ought to ask for.

A regular studio camera, as Fig. 2, will probably be suitable only to a professional portraitist, but as there are many amateurs who lay themselves out for portraiture, and as to prevent fatigue on the part of either and confusion on the part of operator, it is well to have every convenience. We have shown the general appearance of a studio camera that will fulfill every condition of perfection.

Not the least important part of the camera is the "dark slide" or "carrier" already mentioned. As it is the receptacle wherein the sensitive plate is carried, and as it comes into play at a time when the operator needs all his faculties about him, the dark slide must not only be thoroughly strong and ab-

solutely light-tight, but should be of such neat workmanship as to work certainly and "sweetly" under all circumstances.

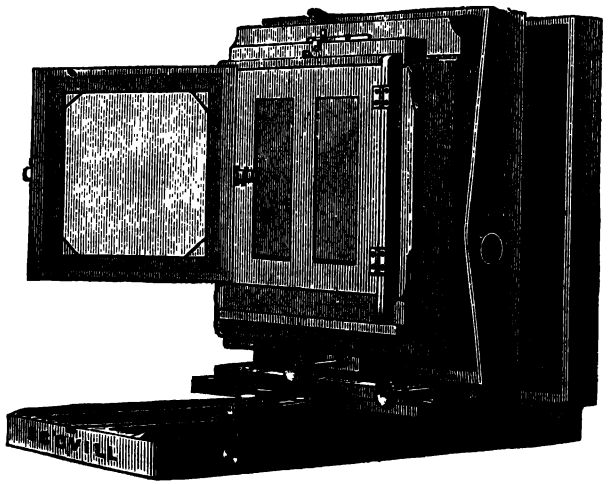

FIG. 2.

For dry-plates, now almost universally used, the slide is usually made "double," carrying two plates back to back, with an opaque partition between them. The double slide, as a rule, opens at one end, after the manner of a long pocket-book. The partition must separate the plates over all their surface, and may conveniently be hinged on the slide.

When it is desired to use in the dark slide a plate of a size less than the full size of the slide, we use what is known in England as a "carrier," in America as a "kit," merely a frame fitting internally the small plate, externally the dark slide rebate.

In America the "shutter" of the dark slide—the part removed from the front of the plate during exposure—is so made as to pull right out of the slide, having a "cut-off" to prevent light entering as the shutter comes out and is replaced. In England the shutter has usually a "stop," which prevents it from coming right out, and hinges which allow it to be folded out of the way and out of the wind during exposure. We do not venture to decide between these two systems; each has its merits.

"Roller slides" or "roll-holders" for carrying paper films shall be noticed later.

The considerations that regulate the choice of supports or stands for the camera are pretty much the same as those regu-

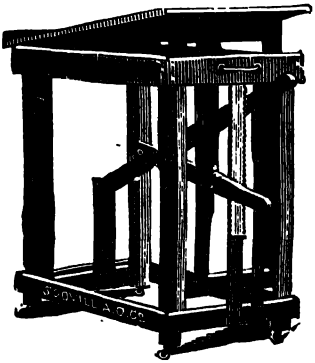

FIG. 3.

lating the choice of the camera itself. The studio stand must have every motion, irrespective of weight, and two good sam-

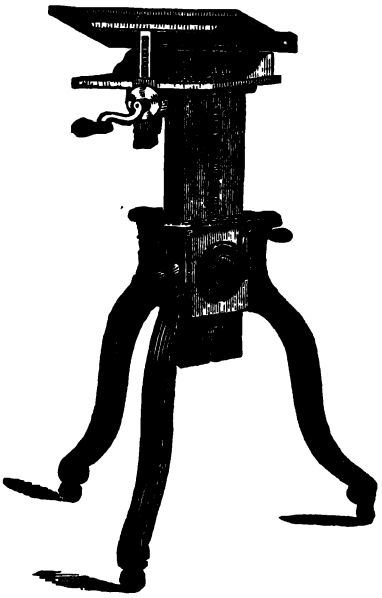

FIG. 3*a*.

ples are shown at Figs. 3 and 3*a*. A stand for outdoor pur-

poses must be as rigid as possible, consistent with portability; should have sliding legs to meet contingencies of very uneven ground, but should, withal, pack into as small bulk as possible. The point upon which rigidity chiefly depends is the breadth and force of grip with which the tripod head is grasped by the tops of the legs. Fig. 4 shows a good tripod stand.

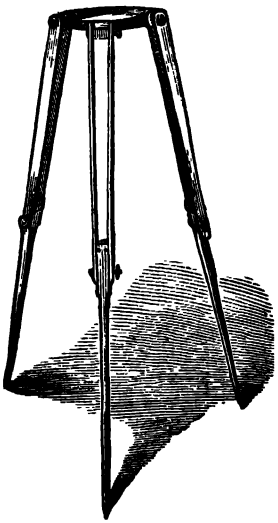

FIG. 4.

Photographic lenses are of a few different types, and made of many different focal lengths. The focal length of a lens is really the paramount consideration, provided, of course, the manufacture is good. Each type of lens is made with a view to meet certain special requirements, to a special degree, and a good lens for any special purpose is really a pure compromise between a number of qualities, special attention being given to the special quality required for the special purpose. Thus the portrait lens, the triumph of photographic optical compromises, is so made as, with the least possible sacrifice of other qualities, to give the greatest possible rapidity of action. The portrait lens was the outcome of the struggle for rapidity at any price, in the days of slow plates; it is now gradually falling into disuse, and its place is being taken by the rectilinear, or symmetrical

lens. The rectilinear lens is formed of two combinations, sometimes alike, sometimes dissimilar. Its uses are at least two-fold, it secures rectilinearity of lines in the camera image, and it enables us, under certain conditions, to work rapidly; hence we have the term "rapid rectilinear," or "rapid symmetrical." We have other "symmetrical" lenses, which, by reason of their special uses, cannot be used at all times for rapid work. The term "wide-angle" is so frequently used, without comprehension of its true signification, that we explain. The "covering power" of a lens depends mainly upon its focal length, and if we use a lens to cover a plate large in proportion to the focal length of the lens, we are using that lens at a "wide-angle"; so it has come about that lenses made with a view to cover a plate large in proportion to their focal length are called "wide-angle lenses." A lens is used as a narrow, or wide, or medium angle lens according to the size of the plate upon which it is used, in proportion to its focal length. A complete treatise on these subjects would require a vast amount of space, more than we can give the subject here.

The so-called "single" lens has certain qualities which place it, in our estimation, higher than any other kind of lens. The number of reflections inside the lens is reduced to a minimum, and the result is a quality, especially in the shadows, not given by doublet or triplet lenses. Until lately the single lens had to be so "stopped down" as to make its action very slow, but this defect has, to a great extent, been rectified; the other defect is that when a single lens is made to embrace too wide an angle, straight lines in the subject are distorted in the photograph. This defect has been greatly exaggerated, and we believe that the cases where the use of a "single" lens, used at moderate angle, is not permissible, are much more rare than is generally known by operators, or admitted by opticians. For portraiture the writers have found the "single" lens inferior to no other type of lens, but it is advisable that the single lens, for this purpose, be made to work with as wide an aperture, and be used at as narrow an angle, as possible.

"Group lenses," so called, are compromises between the portrait and the rectilinear types. "Wide-angle rectilinears"

are made so as to give non-distorted lines while working at wide angles. Perhaps the type of lens that will most completely meet every class of requirement is the rapid rectilinear, and lenses of this type go under many different names in different countries.

The focal length of lens necessary to cover a plate may be calculated from the diagonal of the plate. In cases of necessity, lenses may be used of focal length less than the diagonal of the plate, but, as a general rule, the focal length ought to be at least 50 per cent. over the length of the plate.

The exposure required depends, so far as the lens is concerned, entirely on the proportion of the area of aperture to the focal length at which the lens is being used. If a lens is focused on a very distant object, as the sun, when the sun-image is in focus on the ground-glass of the camera, the sun is in the position known as the anterior conjugate focus of the lens, and the ground-glass is at the posterior conjugate focus, or, briefly, the solar focus. The focus of a lens is usually measured from the "stop," in case of a combination lens, from the lens itself in the case of a single lens, to the ground-glass. This is not *strictly* scientific. But if we focus a closer object, say ten feet off, with a lens of about four inches focus, principal focus, the ground-glass will be found further from the lens than it was when the sun was focused with the same lens; the ground-glass is still at a focus of the lens, but it is not the solar focus, and, in calculating our exposure by means of the proportion of aperture to focus, it is not the sun focus we have to deal with, but the focus of the object which we are focusing; a very different matter in the case of close objects. From inattention to this point persons are often greatly deceived in their exposures when working upon near objects. The proportion of aperture to focal length is usually called the "intensity ratio," and expressed as a fraction thus: $\frac{1}{x}$ or $\frac{f}{x}$, x being the focal length in inches, and the numerator of the fraction being the measure of the aperture. "Stops" or "diaphragms" are always sold with lenses for photography; these stops may be separated from the lens and used by being placed in a slot made for the purpose in the lens tube, or they may be fixed

to the lens and rotated so that any of the apertures may be used. The stops are usually so cut as to give, with the lenses to which they belong, intensity ratios as follows: $\frac{f}{4}$, $\frac{f}{6}$ (these two usually confined to portrait lenses); $\frac{f}{8}$, $\frac{f}{11.3}$, $\frac{f}{16}$, $\frac{f}{22.6}$, $\frac{f}{32}$, $\frac{f}{45.3}$, beyond which it is not usual nor, indeed, advisable to go, except in special cases, when $\frac{f}{64}$ may be used. These terms simply express that the solar focal length of the lens is 4, 6, 8, 11.3, etc., times the diameter of the aperture. Exposures are calculated by comparing the *squares* of the denominators of these fractions. If at $\frac{f}{16}$ the proper exposure is found to be ten seconds, the exposure at $\frac{f}{32}$ will be not twenty seconds but forty seconds.

As $16^2 : 32^2 :: 10 : 40$.

In calculating exposures for close objects, the caution above given as to real focal length must not be neglected. Some opticians number their stops according to an arbitrary table drawn up by a committee of the Photographic Society of Great Britain. A table will be found at the end of this book showing the connection between the so-called "Uniform System" of numbering stops and—what is really the crucial point—the intensity ratios.

For the special province called instantaneous photography, mechanical "shutters" are required. The simplest and the oldest is the "Drop" or Guillotine shutter, figured No. 5,

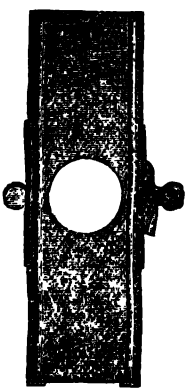

FIG. 5.

wherein a loose piece with an aperture falls across the

axis of the lens, the shutter being placed sometimes on the hood or front of the lens, sometimes at the back of it. As, usually, it is desirable to expose the foreground of a subject more than the upper part, this form of shutter is preferably placed behind the lens; for if it is in front, the increasing velocity of the falling *plaque* of wood, metal, or other material allows the foreground less exposure than the upper part.

Shutters of this type should have their aperture by no means less than the working aperture of the lens. An aperture longer than the lens diameter is recommended, and the action may be quickened by an elastic spring.

Many shutters are used in the centre of the lens, and, in certain ways, these shutters have great merits. As a rule, the apertures of these shutters are of square or diamond-shape, and cross each other in the act of exposure. When a shutter acting in this way is placed either in front or in rear of the lens, the inequality of lighting inherent in certain types of lenses is exaggerated; when the shutter is placed in the centre of the lens, not only is this defect not exaggerated, but the result

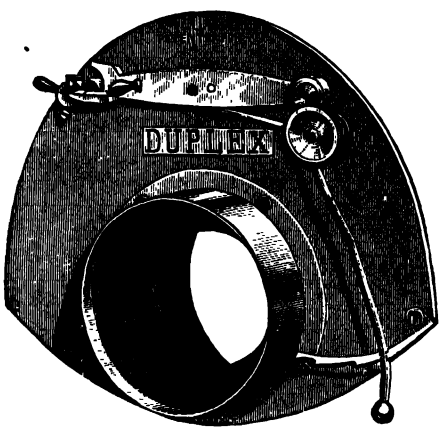

FIG. 6.

is better, in this respect, than if the lens were used with the same stop and the lens-cap. There is an advantage to be found in shutters opening from the centre, viz., that the loss of time occupied in opening and shutting is made up for by the fact

that the shutter acts during part of the exposure as a stop. The advantage of using a stop is that, thereby, greater sharpness is obtained over the plate, and planes of the subject at various distances from the lens are brought more evenly into focus on the plate.

The markets teem with shutters for instantaneous exposures. If the purchaser can procure one which will work without jar *during* the exposure, which will, at will, give an exposure as short as one-hundredth of a second, or as long as half a

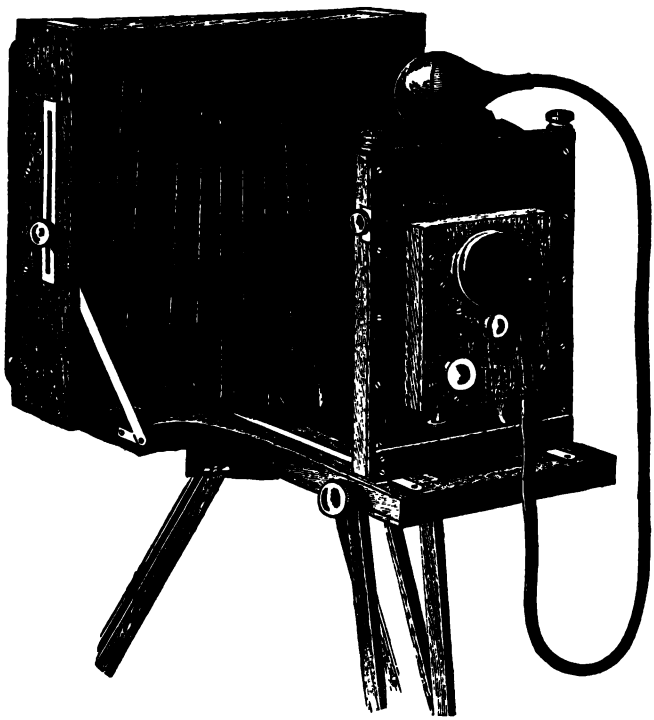

FIG. 7.

second; if it give either even illumination all over the plate, or extra exposure to the foreground; if it allows the full amount of light to act on the plate during the greater part of the duration of its working ("co-efficient of light"); and if, in addition, it can be made to give an exposure regulated by the

hand of the worker, that purchaser will not regret his purchase. It would be invidious, from such a number of good shutters, to single out any one as the best, but we give figures (6 and 7) of two good shutters, one well known in America, the other in Great Britain.

With the ordinary lens-cap, by hand, an exposure can be, with a little practice, made not exceeding one-fourth or one-fifth of a second, but the performance is, in some hands, risky.

It will be noticed that as yet we have not written a word of suggestion as to *size*, nor do we propose to more than allude to the matter. The photographer must choose the size for himself, according to his bank account, his bodily rigour, his available leisure, and his object. Expense, exertion, and attention required, all increase, at an enormous rate, as size of work increases. The smallest size commonly used is known as "quarter-plate," the size of plate being $4\frac{1}{4}$x$3\frac{1}{4}$ inches. The *impedimenta* for work of this size are not worth mention, and the expense moderate. By an easy process lantern-slides can be produced from quarter-plate negatives, and we doubt whether we could name a nobler finale to a set of photographic operations than a good lantern-slide, for which we shall give very careful instructions in this book.

"Half-plate," $6\frac{1}{2}$x$4\frac{3}{4}$ (in England), $6\frac{1}{2}$x$4\frac{1}{4}$ (in America), is, perhaps, the smallest size from which a direct print can be made that will not look trivial.

"Whole-plate," $8\frac{1}{2}$x$6\frac{1}{2}$ inches, is a very convenient, and in our opinion, elegant size.

The largest size we can recommend for amateurs, in a general way, is 10x8 inches, which most persons will find quite enough to carry into the field.

For portraiture, where weight is a matter of no consideration, we recommend the largest size the would-be purchaser can afford. We confess ourselves sick of the everlasting "cabinet" portrait, and its little brother, the "carte." If the amateur must trespass on the domain of the professional, let him do so "*en grand seigneur*."

Besides such necessaries as we have touched upon, there are

a number of smaller articles which will be required. These we shall merely advert to.

A cloth, known, too often, as the "black cloth," or "black rag," is used to cover the camera while focusing is being done. This cloth looks much better when dark-colored, but not black, and waterproof cloth is far superior to velvet, because it *is*

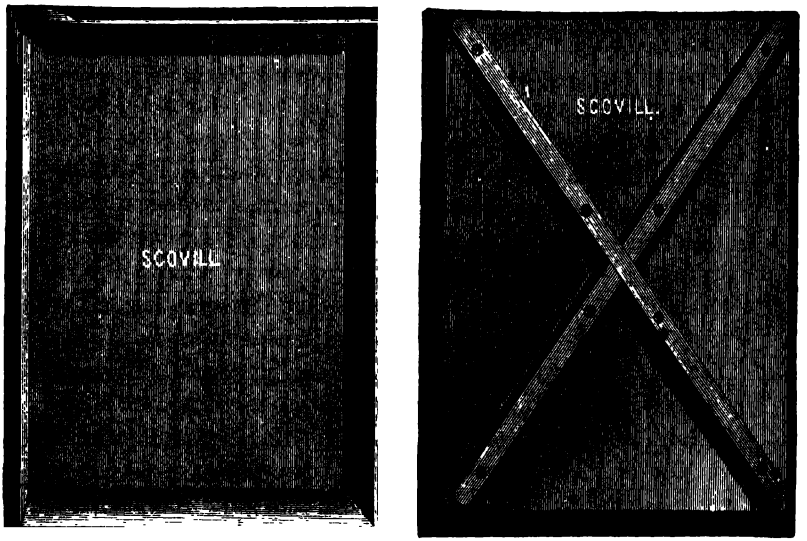

FIG. 8.

waterproof, and often useful in that capacity; because it has a

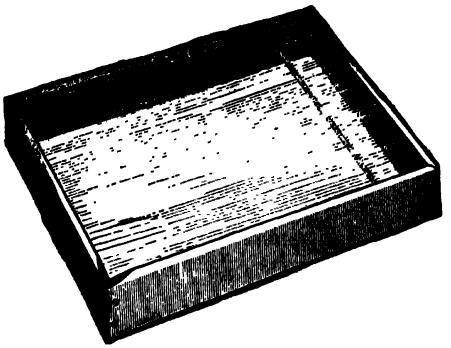

FIG. 8*a*.

better appearance, and because it does not cling to the cap, or hair, when the head is being withdrawn from under it. The

cloth should be tied, or buttoned, on to the camera front, and should be of ample size.

Dishes for development of ordinary dry-plates should be black, and papier-maché is perhaps the best material. To save extra quantity of solution the bottom should be flat, but in order to avoid staining the fingers in lifting the plate up for examination, either a hook must be used, or the dish made with ridges at bottom. For other operations, as "toning," porcelain dishes are to be preferred. For the smaller sizes, glass dishes are found very elegant, but they have the defects of weight and brittleness.

Graduated measures of different sizes, scales and weights, filter-funnels, and other laboratory requisites are necessary in small quantities, but need no remark.

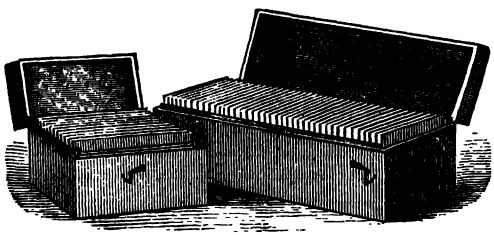

FIG. 9.

Plate boxes for storing sensitive plates must be made carefully light-tight, and of such wood or other material as will not affect the most sensitive plates (Fig. 9).

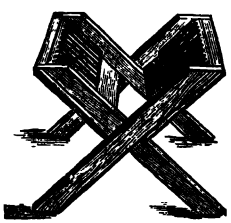

FIG. 10.

A rack for drying plates is preferable to leaning the plates against a wall, or other object to dry (Fig. 10).

Other apparatus will be described, as the need for it turns up, in our future chapters.

CHAPTER IV.

THE DARK-ROOM.

THE above is the name technically, but not accurately, given to the apartment wherein are conducted such operations as would be hurt or impossible in actinic light, by reason of its action upon our sensitive salts, as described briefly in Chapter II. The requirements of an operating-room are of the simplest, but it may not be amiss to give a few hints as to the easiest and best way to arrange an apartment for the purposes with which we propose next to deal.

Many amateurs find it impossible or highly inconvenient to secure an apartment of any kind for their work, and for such a "dark-tent" may be the most convenient way out of the difficulty. But it is probable that each of our readers will be able either to adapt, or to find, or to build an apartment for his photographic requirements.

If a room is to be used only occasionally or temporarily as an operating-room, the most required will be to stop out all white light by whatever means appear most handy. A window may either be blocked up entirely by opaque material, such as thick brown paper, or brown paper in several layers, or it may be preferable to block out the light only partially with opaque material, and allow some light into the room through some medium, such as ruby glass or orange or yellow paper. The color and thickness of these light-filtering media depend on the sensitiveness of the photographic substances we propose to use. For wet collodion, dry collodion, or gelatine-chloride plates, yellow glass or lemon-colored paper will be sufficient protection, even from daylight. For processes wherein we use gelatine-bromide of silver in a moderate state of sensitiveness, as for "lantern-slides," "bromide prints," or "slow gelatine-bromide

plates," an orange-colored filtering medium, a single ruby glass, or "canary medium" may be used. With very rapid gelatine-bromide plates we must use several thicknesses of orange or canary paper, or we must add to the ruby glass a thickness of yellow glass. If we are going to expose our sensitive material to the light for a prolonged period, as in emulsion-making, we must redouble our precautions in this line, and for orthochromatic work (see Chapter XVIII), we must not only restrict ourselves to ruby light, but we must, as far as possible, restrict the quantity of that. If there be any doubt as to the "safety" of our light, we should expose a sample of the material with which we are working under a "sensitometer screen," or under a negative, to the suspected light, and ascertain by development whether any light-action takes place. We may place one

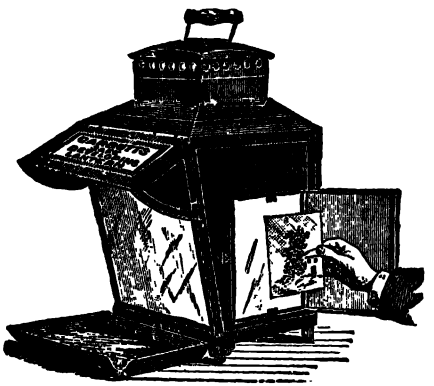

FIG. 11.

of our plates in a book, so that part is protected by the book and part exposed to the suspected light for (say) five minutes. If, on development, any action is observed on the exposed part it is evident that further precaution must be taken with regard to the light.

Alternatively, and perhaps preferably, the light may be entirely, blocked out of the room, and a "non-actinic lamp" used. The variety of these in the market is infinite. We figure one only, Fig 11.

If gas is laid on, we recommend the principle of building a lantern around a jet, so that (1) the heated air and combustion-

products are carried right out of the apartment, if possible; (2) the gas can be raised or lowered from the outside of the lantern.

In the case of a room temporarily used as an operating-room, it is well to cover the tables with waterproof or "American" cloth. A basin or foot-pail may serve as a sink, and any vessel of suitable size and shape may be "annexed" for water. We have, in a hotel bedroom in Italy, made rapid gelatine emulsion, coated, dried and developed plates, with some little exercise of ingenuity, but without accident or failure.

But we venture to say that success will most likely attend operations conducted in apartments made or adapted solely for the purpose of these operations. The apartment chosen or built must be thoroughly ventilated as well as thoroughly light-proof, otherwise the accruing vapors will damage both the health and the success of the operator. A north aspect should, if possible, be chosen for the window. A window should exist in the room, whether that window is to be used for the photographic operations or whether it is to be blocked up during operations. The system of dark-room lighting, which we find most satisfactory, is to have our window glazed with perfectly safe light, but to have, also, our gas lantern lighted and worked from the outside. We commence developing operations by daylight filtered through our "safe" window, and when we come to the point where critical examination is required, we turn up our non-actinic gas lantern, which is provided with various filtering media—viz., clear ruby glass at one side, canary medium paper at another, and ruby glass, ground on one side, at another. Ruby glass ground on one side is one of the most perfect *media* we know. Of "ruby glasses," the safest sample we have ever seen was ordinary "metal-flashed ruby" on one side and "stained yellow" on the other side. Some persons cannot tolerate ruby color; others dislike yellow-greens. The ruby tints are used clear, and often combined with clear yellows. The yellow *media* require the light to be more or less diffused, either by paper or ground-glass, or semi-obscured glass in some form or other. Of

course, a medium that may be "safe" with artificial light might be disastrous if used with daylight; and, moreover, a medium safe with daylight in mid winter may be fatal in spring or summer. The test recommended above is equally useful here.

The sink for an operating-room is often made of stoneware, often of iron. We greatly prefer wood lined with sheet-lead, which does not, perhaps, look so pretty, but does not fracture a measure knocked over or laid too briskly down on it.

The tap should be of the "arm" kind, but the turning of the arm must not regulate the water-flow; there should be a cock to turn the water on and off.

On one side, at least, of the sink, and projecting slightly over the sink, should be a table, lead-lined, and sloping down towards the sink. This is to receive dripping measures, dishes, plates, etc., and to carry the drip into the sink. A slightly-raised ledge, or "beading," round the table, will prevent liquids reaching the floor.

Shelves, cupboards, tables, etc., are evident requirements of an operating-room. Hot water supply is an immense boon. A fixed syphon trough for washing negatives is a great convenience.

The nozzle of the tap should end in a thread, to which, by means of a gas coupling, can be attached a variety of small apparatus, as a rose tap—an invaluable article—a rubber tube, etc.

Drying presses and other matters shall be described as their uses are treated.

The dark-room should be kept, as far as possible, at an even and moderate temperature. Whatever be the fuel used the products of combustion must be carried right out of the room. Gas, in particular, has a noxious effect on many of our products.

CHAPTER V.

"NEGATIVE" AND "POSITIVE."

THE result of every set of photographic operations is either a positive or a negative. A "positive" shows the light colors in nature as whites, the shadows as dark, while a "negative" shows the high lights of nature as dark, the shadows as light. A positive may be looked either *at* or *through*, a negative is not intended for looking at, but is merely intended to be *printed through*, so as to produce what is always our ultimate object—a positive. Positives are very seldom now produced direct from nature, they are almost always produced through the intervention of negatives. A negative is of no value or merit irrespective of the value or merit of the positives which may be produced from it.

We have to deal with "positives" as prints on paper, on opal, or on other opaque or semi-opaque supports; and with 'transparent positives," as "lantern-slides," window transparencies, etc.

"VEHICLE" AND "SUPPORT."

We require for our sensitive salts (1) a substance wherein they may be suspended, because we cannot, in practice, spread or use them on a hard, repelling surface, such as glass. The suspending substance is called the "vehicle," and may be collodion, albumen, gelatine, paper, or other substances. (2) Some "support," to hold our suspended sensitive substances in such a layer and condition, that we may expose a considerable surface of our sensitive substances to light-action, and be able, thereafter, to manipulate them. Glass is the commonest "support" now in use, but we have, also, acting as supports, paper, gelatine films, metal plates, etc., etc.

The support may be "temporary," as in cases where, after operations are complete, we strip our vehicle, with its suspended substances, from the temporary support; or the support may be "permanent," as in the cases of the glass of our ordinary negatives, or the paper of our ordinary prints. Paper, among other substances, may be at once vehicle and support, temporary support and permanent support.

We propose first to deal with the wet collodion process, which may be used as (1) a negative process, (2) a transparent positive process, as in the case of lantern-slides, (3) an opaque (or simply) positive process. As the use of wet collodion, under No. 3, is now rare and confined to the production of positives not remarkable for excellence at the best, we shall not do more than allude to it under this heading.

We cannot do the wet collodion process full justice, as we are well aware, in our limited space, but the process is so interesting, so educative, and so beautiful in many of its results, that, though of late years it has fallen into comparative disuse, we feel impelled by our own wish, as well as for the good of our readers, to devote some space, however unworthy of its merits, to the process.

CHAPTER VI.

THE WET COLLODION PROCESS.

In this process collodion forms the vehicle, glass the support, and silver haloids the sensitive salts. The latter salts are formed in the vehicle by the chemical action known as "double decomposition." The vehicle at first holds in suspension an iodide (as of potassium), or a bromide, or a chloride, or all three; these halogens, coming in contact with silver nitrate in solution, combine with the silver to form the silver haloids in the vehicular film of collodion, and these haloids are the salts that receive the light-action, and determine another action known as development, which is really a reduction of the silver to the metallic state. It is utterly impossible, in a few words, to explain, even in outline, a series of chemical actions such as this; the safer way, for all parties, will be not to attempt desultory and partial theory.

Collodion is a solution of gun-cotton in ether and alcohol, and is sold ready for our purpose either "iodized" or with a separate bottle of "iodizer," to be mixed with the plain collodion, according to instructions. As a rule there is, along with the iodide, a certain proportion of bromide, and for landscape work a good proportion of bromide is desirable.

A plate of glass, being thoroughly cleaned, is "coated" with iodized collodion, and is thereafter immersed in a solution of silver nitrate. The now sensitized plate is exposed in the camera, brought back to the operating-room, where it was sensitized in non-actinic light, flooded with a developer, consisting of a salt of iron in solution, washed, "fixed," and washed again, when it is supposed to be a finished negative. To take these operations in detail:

Cleaning the Glass Plate is usually performed with a mix-

ture of alcohol and ammonia, containing a little rouge powder or tripoli. If the plate has been used previously, the cleaning must be performed with all the more care, and a preliminary bath of nitric acid and water is desirable; in any case, the plate, back and front, must be scrupulously clean and free from the *slightest trace* of grease or organic matter of any kind. Sometimes the plate is flowed twice with albumen thinned with water and alkalized with ammonia, and, of course, most carefully filtered; this is preferable to having a dirty plate, but is apt to disorder the silver-bath. After the plate is cleaned, it must be "polished" with a scrupulously clean chamois leather. The plate must not be rubbed with silk immediately before coating.

Coating the Plate with Collodion.—This is an operation which requires both care and practice. In no process of photography is more attention to apparently trivial details re-

FIG. 12.

quired than in the wet collodion process; absolute cleanliness, freedom from dust, and method are required at every step. The first crucial operation is that of "coating the plate." The collodion containing the "iodizing" agents must be kept clear of dust, free from solid particles of collodion, in a bottle of such form as to permit of neat and even pouring, and to prevent solid or semi-solid particles from settling on the

plate. A suitable bottle is shown in Fig. 12. The collodion must run evenly over the whole of the face of the plate, must run over no part twice, nor stop for any considerable time on any part. The operation is performed in the following way, and those uninitiated, yet unwilling to waste collodion, may try their "prentice hands" with milk or thin cream.

The polished plate is taken by one extreme corner, or, much preferably, on a pneumatic-holder scrupulously clean (Fig. 13).

Fig. 13.

The face and back are quickly dusted with a camel's-hair brush, and the plate held in the left hand in the position shown in the figure, A E being next the operator's body.

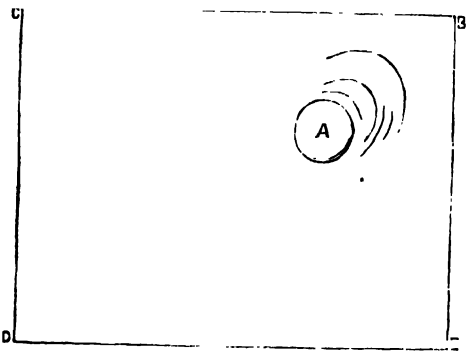

Fig. 14.

A pool of collodion is poured about the point A in sufficient quantity to more than cover the whole plate, the pool as it widens is guided by tilting the plate slowly but steadily towards B, then around towards C, then towards A; the now broad wave is directed towards D, at which corner it is poured off the plate into a second bottle, through a filter if convenient.

The plate, while the collodion is running off, must be gently and slowly rocked by depressing alternately corners E and B, and the corner E may be gently touched by the neck of the second bottle, or the filter, but must on no account be ground against any hard substance. When the collodion is "tacky," or takes the impression of the skin of the finger at corner D, the plate must without delay be placed in the "nitrate bath." Many operators hold the plate, while coating it, with the narrow end next the body, pouring the pool of collodion near the right top corner; some pour it on near the left side next the body, but we, after considerable experience, prefer the method we have given.

The "Silver Bath," or "Sensitizing Bath," is as simple to make as it is difficult to keep in order. Therefore, it should be made in two batches at once, one solution to replace the other when the first used goes wrong:

Silver nitrate (crystallized).....35 grains
Pure water..... 1 ounce

in sufficient quantities, of course, to cover the plate thoroughly in the bath. This is the most generally useful strength, and the limits of variation are but small. Very cold weather may indicate a bath five grains per ounce stronger. A trace of iodine must be added to this bath, either by adding for every ten ounces of "bath solution" about a grain of potassic iodide direct, or by coating a plate with iodized collodion and leaving in the bath for some hours. If the addition of iodide be neglected, pinholes (tiny transparent spots) will surely affect all the plates first sensitized in the bath. The water must be absolutely free from organic matter; water distilled in a glass or clean metal "still" will answer, or rain water caught direct from the clouds in a clean—not metal or wood—vessel. Even rain water is not entirely to be trusted. A crystal of silver nitrate should be placed in about a pint of rain water, the vessel containing it allowed to stand some days in bright light, and the water carefully filtered through pure filter paper. To prepare the bath: Dissolve the full quantity of silver nitrate in about one-half the full quantity

of water, add the iodide if the addition is to be made directly; then make up with water to full bulk, and filter.

The "bath" is at all times, after long use, liable to become supersaturated with either (1) iodine, or (2) collodion solvents —ether and alcohol. No. 1 is indicated by "pinholes" in the negatives; to cure this, dilute the bath to half its strength, make up to original strength with silver nitrate, and filter carefully. If No. 2 be indicated by unequal sensitizing and streaky development, the application of heat will drive off the offending solvents. A third adulteration, that of organic matter, is more difficult to get rid of; it will be indicated by fog, "veil," dirty negatives, etc. To remove organic matters which get into the bath from the fingers, the clothes, the atmosphere, or dirty plates, make the solution distinctly alkaline with sodic carbonate, and place the solution in a strong light for some days, after which filter out the black deposit, re-acidify with nitric or acetic acid, and filter again.

The sensitizing bath must never be used alkaline; it must be tested for acidity with blue litmus paper. If the paper does not turn red, acid—nitric or acetic—must be added to the bath till the paper shows distinct redness. For negative work, acetic acid is, perhaps, preferable; for positives, nitric acid.

When the collodion has "set" on the plate, as described—the time requisite for setting depending chiefly on the temperature, and varying from twenty seconds upwards—the plate is to be immersed in the "bath."

Two kinds of receptacles are used for the bath solution. In some countries we find the dipping bath almost in universal use; in other countries an ordinary flat porcelain or glass dish is used. The dipping bath, figured at No. 15, requires a "dipper" of silver, porcelain, or varnished wood (the last *not* strongly recommended), and it also necessitates a much larger quantity of solution than the flat dish, but it has the advantage of better protecting the plate and the solution from dust and other impurities. We leave the choice to our readers, saying only that, having used both, we prefer, on the whole, the flat dish, keeping it carefully covered and the solution frequently filtered. The plate is to be immersed in the solution

steadily, without either a sudden plunge or a hesitating stoppage, and the lower end of the plate, where the collodion is probably thicker, is to be immersed first. In a few seconds a change will be seen on the plate, a kind of gray or bluish-gray film appearing, due to the formation, by "double decomposition," of the silver haloids. After the plate has been in the bath about forty-five seconds, the thick collodion end, if in a flat dish, the whole plate on the dipper, if in a dipping bath, should be gently and only slightly raised. The sensitization is complete when there is no longer any appearance of "greasiness" on the plate, that appearance being due to the collodion

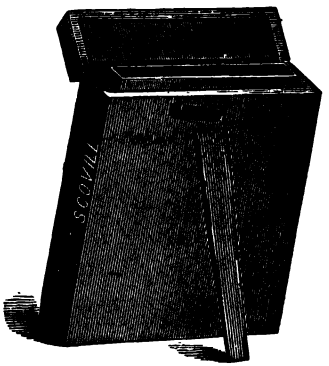

FIG. 15.

solvents. The plate should now be covered with a perfectly even film of gray or bluish-gray (according to the salts in the collodion) color. Of course, the sensitizing of the plate must be done in non-actinic light—in the present case yellow glass, or even a candle shaded by yellow paper will afford sufficiently safe illumination.

The plate, now sensitive, is raised from the bath slowly, the drops at the lower end blotted off on *clean* filter or blotting paper, the back wiped with similar paper, and the plate is placed in the dark-slide, propped up in the position it will occupy in the camera. The plate being placed in position, film to the front and against the silver or glass corners in the slide, a piece of red blotting paper, which may with advantage be damped, is placed behind the plate, and the slide is closed.

As a rule, the thicker part of the collodion film should be placed at the upper part of the dark-slide which will receive the foreground of the picture. The slide once charged in its proper position must never be waved about nor reversed so as to cause the silver solution to run back over the plate; it must be carried steadily, and if laid down must preserve the position in which it was charged.

We then proceed to make an exposure (see Chapter XIII.), and after exposure, return to the dark-room with the slide, which we again prop up in its former position, till we are ready to develop the plate.

Development.—An average iron developer may be formulated thus:

Iron protosulphate	12 grains
Acetic acid (glacial)	30 minims
Water	1 ounce
Alcohol	q. s.

For the acetic acid we may substitute nitric acid, 1 minim. The quantity of alcohol is regulated by the amount of alcohol in the bath, a new bath necessitates almost no alcohol in the developer; as the bath ages, so the alcohol in the developer must be increased, otherwise streaks will appear.

The iron protosulphate must be fresh, and of a fine green color; the yellow crust, often seen, is due to oxidation, and does mischief acting as a restrainer (Abney). The proportions of iron may vary greatly; as little as five grains, and as much as forty grains, to each ounce, may be used under certain conditions. One of the writers used with great satisfaction, in Italy, the following:

Ammonia sulphate of iron	77 grains
Acetic acid	70 minims
Alcohol	q. s.
Water	3 ounces

The acid is in each case used as a "restrainer" or "retarder." Without it the image would flash out, fog, and be not only uncontrolable, but useless.

The plate is taken out of the slide by "safe" light, prefer-

ably with the pneumatic holder (*vide supra*), is held over the sink with the thicker end of the collodion film next the operator. Sufficient of the developer, amply to cover the plate, is taken in a cup, and *swept over the plate* in one wave, not violently, but without hesitation; if possible, no solution should be spilled. This is allowed to *move* over the plate for half a minute, more or less, and is then poured off into the sink, or into a residue jar. If the image flashes up gray, the exposure has been too great; if it comes up reluctantly, or black and white, or not at all, the exposure has been too short, in each case supposing the "bath" and the developer in proper order. In place of acid, certain viscous substances are sometimes used as "retarders" of development, making the developing solution more "syrupy," and so offering more resistance to the solid particles traveling through it. Among substances recommended for this purpose are sugar, glycerine, gelatine, and the "collocine" of Mr. Carey Lea.

Re-development.—It is probable, especially if the wave of developer carries any solution over the edge of the plate, that the image, after development, will not be dense enough for printing purposes, and possible that there may be a lack of detail, as well as of density. In this case the plate is washed under the tap, and a further dose of developer is applied, with the addition, this time, of some silver nitrate. To each ounce of the fresh developer, in the cup, we may add ten or twelve drops of a ten per-cent. solution of silver nitrate. (Silver nitrate forty-eight grains, water up to one ounce, acidified with nitric acid.) This is applied to the plate, and allowed to move over it as before, density and detail will both increase. If, after development, the image is weak, and wants detail, re-development is wanted; if weak, and full of detail, it is contra-indicated. In the latter case intensification (see p. 44) is indicated as necessary.

Fixing.—The plate, after re-development, is again washed and fixed (*i. e.*, the unaltered-by-light silver salts are dissolved) by pouring on either:

Potassic cyanide	25 grains
Water	1 ounce

Or,

Sodic hyposulphite	100 grains
Water	1 ounce

till the yellow veil disappears from the plate entirely.

The potassic cyanide is highly poisonous, even by absorption, its fumes are noxious to some persons; the sodic salt is harmless. After the plate is perfectly "fixed" or "cleared" it must be carefully washed, especially after "hypo."

Intensification is resorted to for plates that are wanting in density, and consists of an operation very similar to re-development; the same solution may be applied as for re-development, or the iron, this time, may be replaced by three grains of pyrogallic acid. The silver nitrate is to be added as before in re-development. The plate is finally washed and allowed to dry. Drying before a fire will slightly increase the density.

These processes are practically the same for a transparent positive (as a lantern-slide) as for a negative. The wave of developer may be allowed to carry a little solution over the edge of the plate, and any increase of density must be administered with caution.

The collodion film is very delicate, and requires to be protected by a varnish usually composed of gums dissolved in spirits. Varnish is sold by every dealer, but may at need be made thus:

Seed lac	1 pound
Methylated spirit	1 quart

Keep some days in a warm place, shaking occasionally. After four days decant and filter.

To apply varnish: Heat the plate to blood heat, apply the varnish after the manner of collodion, drain well, removing the last drip by resting lower part of the plate on bibulous (filter or blotting) paper. Then heat again till the back of hand cannot bear it. The varnish must not be allowed to dry cold.

For certain purposes negatives in black and white are re-

quired. For such purposes—copies of plans, line engravings, etc—the negative may be intensified thus:

Mercuric chloride..... 1 part
Water.. ....20 parts
Acidified with hydrochloric acid.

Immerse in this till the image is almost, or quite, white. Then plunge, after thorough washing, into:

Liquor ammonia, fort..... 1 part
Water.....20 parts

The image will now turn densely black. Wash thoroughly. Dry, and varnish as before.

CHAPTER VII.

A DRY COLLODION PROCESS.

Dry collodion plates are very rarely, if ever, now used for making negatives, but, as the process naturally follows the wet collodion process, we propose to insert here a dry collodion process, which we have used extensively and successfully for lantern-slides, and which *may* be used, if desired, for negative-making. The formula is mainly due to Mr. W. B. Bolton.

Dry collodion emulsion is called "washed" or "unwashed," according to the stage at which it is washed, for washed it always is, at one stage or another. Instead of using a bath of silver nitrate solution, and immersing a coated plate therein, we add the silver nitrate to the liquid salted collodion, thereby producing an "emulsion" of silver haloids in collodion, and that emulsion, sensitive to light, we pour on plates which we thereafter dry. But in the process of "double decomposition," by which the sensitive salts are formed, there are formed other compounds, or "bye-products," which, if left to dry on the emulsion, or on the film, would crystallize, and spoil all our plates. In the "washed" emulsion process these bye-products are washed out of the bulk of emulsion before the plates are coated. In the "unwashed" emulsion process the bye-products are washed out of the film of each plate after it is coated.

Unwashed Collodion Emulsion Process.

The zinc bromide must be dry, or dried by heat on a clean surface. The pyroxyline is that made at, and known as, "high temperature."

Sulphuric ether, .720	3¼	fluid ounces.
Alcohol, .820	2	fluid ounces.
Pyroxyline, (H.T.)	36	grains.
Zinc bromide	59	grains.

Mix in this order, and let stand one day, at least, to settle.

After the above are fully dissolved and any precipitate settled, dissolve ninety grains silver nitrate in a test-tube, with forty-five minims of distilled water, boiling. Boil, in another test-tube, six drams of alcohol .820, and while both test-tubes are at the boil, pour about four drams of the alcohol into the silver solution, reserving two drams for future use. Now take the two test-tubes and the bromized collodion into the dark-room (yellow light will do) and little by little pour the hot alcoholic-aqueous silver solution into the collodion, shaking the latter violently after each addition of silver. After all the silver solution is into the collodion, use the two drams of alcohol in reserve to rinse out the silver which will be crystallized, probably, in the test-tube, and add *that* to the collodion. Shake vigorously for a minute or two. We have now formed a collodio emulsion of silver bromide, which is left to "ripen" for several days. When fully "ripened," the emulsion is filtered through pure cotton wool, glass wool, or swan's-down calico, and plates are coated with it. For this process, the plates should be carefully cleaned, and they should have a substratum of albumen, or an "edging" of india-rubber dissolved in pure benzole. The albumen solution is made by switching the white of an egg with forty ounces of water, adding liquor ammonia till the smell of ammonia is distinctly perceptible, letting stand, and filtering most carefully. This improves by keeping, but the ammonia smell must be kept up. The clean but wet glass plate is flowed *twice* with the albumen, then dried.

The plate coated with collodion emulsion is left till the collodion sets, when it is plunged into *distilled* water, after which it may be washed in ordinarily pure water till greasiness disappears; after this it is placed for about a minute in one of the following solutions:

1. Coffee (ground)..... 2 ounces
   Boiling water..... 10 ounces

carefully filtered.

2. Bitter beer..... 10 ounces
   Pyrogallol..... 10 grains

filtered.

After No. 2 the plate is to be washed before drying, but not after No. 1. Drying may be accelerated by gentle heat.

Washed Collodion Emulsion.—Process of sensitizing is very similar to that given for unwashed emulsion.

Ether, .720	3½ ounces
Alcohol, .820	2 ounces
Pyroxyline	48 grains
Zinc bromide	72 grains

To sensitize use, this time, silver nitrate 120 grains. The ripening is allowed to proceed as before, and thereafter the emulsion is poured out into a large, flat, clean dish in the dark-room, and allowed to set thoroughly. As a skin forms on the top, it is broken with a clean bone, horn, ivory or silver instrument, so that it may "set," by evaporation of the solvents, to the very bottom. The emulsion is then cut or broken or torn into very small shreds, and washed in running water for several hours. The "pellicle," or dry emulsion, after being broken up, may be put into a tea-pot, a piece of muslin tied over the top, and a stream of water directed down the spout for a night. The pellicle is next thoroughly dried, first, by squeezing, next, by submersion under alcohol for an hour or two. It is then dissolved in ether and alcohol, thus:

Pellicle	20 grains
Ether	4 drams
Alcohol	4 drams

The plates are coated with this, and require only to be dried.

Development.—For lantern-slides the developers we prefer will be found under the heading appropriate, page 176. We here briefly state a method suitable for plates made by this process, and exposed upon landscape subjects. The required exposure, we may say, is very long compared with other negative processes in common use.

Flow the film with

Methylated spirit	1 part
Water	1 part

for half a minute. Wash under the tap.

Col. Stuart Wortley's Developer.

1. Pyrogallol	96 grains
Alcohol	1 ounce
2. Potassic bromide	120 grains
Water	1 ounce
3. Liquor ammonia	6 minims
Water	1 ounce

Developer consists of

No. 1	6 minims
No. 2	3 minims
No. 3	3 drams

mixed.

This is poured upon the plate, or into a flat dish in which the plate is placed, and after a short time the image will begin slowly to appear and gradually to gain strength, Development does not progress nearly so quickly as with wet collodion.

Re-development, fixing, intensification, and varnishing may be conducted exactly as in the wet process; "pyro" being preferable to iron for "strengthening" processes.

As a rule, a dry collodion plate for landscape work, the film being very thin and transparent, requires "backing." This is done by painting the back of the plate with a pigment of the following nature (Abney):

Powdered sienna, burnt	1 ounce
Gum arabic	1 ounce
Glycerine	2 drams
Water	10 ounces.

This is to be removed before development, a sponge being used.

The ferrous oxalate developer gives fine results with dry collodion plates (see page 91.)

CHAPTER VIII.

GELATINE EMULSION PROCESSES—PRELIMINARY.

We cheerfully acknowledge, and proudly assert, that in the markets of every civilized country, plates prepared for photographic purposes, with gelatine emulsion, are found, excellent in their qualities, and suitable for every purpose for which they may be intended. We do not expect that any person making emulsion on a small scale, or with limited appliances, will produce plates of such even perfection as those of professional plate-makers; and we are pretty confident that the amateur plate-maker will not save any money by his plate-making. *But* we urge upon every one who wishes to work with intelligent comprehension of what he is doing, and every one who has the ambition to *further photographic knowledge*, by his own efforts to acquire a perfect knowledge of, and facility in, the production of gelatine emulsion, and the preparation of plates, or paper, therewith. No treatise on modern photography would, in our opinion, be worthy the name, unless it showed evidence of an attempt, at least, to initiate its readers into this, the most important photographic process of the present day. Our modest directions shall be given, to the best of our ability, in such a way that any intelligent person following them, shall be able to produce a good emulsion, and with a little practice, to prepare good plates; at any rate, so that any person reading them with moderate attention shall grasp the facts guiding our practice, and the conditions necessary to ensure success. The change of "vehicle" from collodion to gelatine carries in its train more important considerations than might, at first sight, be expected. In a collodion emulsion the collodion is practically a purely mechanical *menstruum*, in a gelatine emulsion the part played by the gelatine is more, by far, than mechani-

cal. Many of our most mysterious and aggravating failures arise from this fact. Again, one property of gelatine is, that it permits of a silver haloid being formed in it in a state of very fine division, and of that fine state of division being carried through various stages to a much coarser state; as a number of "marbles" lying together expose to light a much larger amount of surface than a much larger number of "shot drops," so a coarse-grained deposit of silver haloid is more affected by light than a fine-grained one. Moreover, the gelatine is a more powerful halogen absorbent than collodion, and so conduces to greater sensitiveness; and lastly, the gelatine, apparently protecting more strongly the silver haloid molecules, permits of a much more vigorous reducing agent being applied in development.

The haloid chiefly used in gelatine emulsions, for negative work, is silver bromide, and as its general sensitiveness, as well as its special sensitiveness to the less refrangible rays, is greater than that of iodide, we have to take greater precautions as to safety of our light with gelatine bromide emulsion than with either collodio-bromide or the iodide of the wet collodion process. In fact, if we propose to make gelatine bromide emulsion of any suitable degree of sensitiveness, we should use for illumination either ruby and yellow glasses, or several layers of orange paper, or other fabric.

Certain apparatus must be provided before any other step should be taken towards emulsion making.

A drying-press will be required for drying the plates after they are coated, and it must be noted that aqueous solution of gelatine is by no means easily or speedily dried. The press must, of course, be absolutely light-tight, and the drying must depend on a constant current of cool, dry air rather than on any system depending on heat. We illustrate by a cut, Fig. 16, a press, the principle of which may serve to guide others who wish to construct a drying-press.

Drying-closet, designed by one of the writers (see *Photographic Times*, 1888, pp. 133–135), 6x6 feet by 9 feet high; cross section of air-passage one square foot area. The air is drawn from a veranda and heated by an oil stove. No

burnt air comes in contact with the plates, the heat being used solely to create draught. (For full description, see article *cit. sup.*)

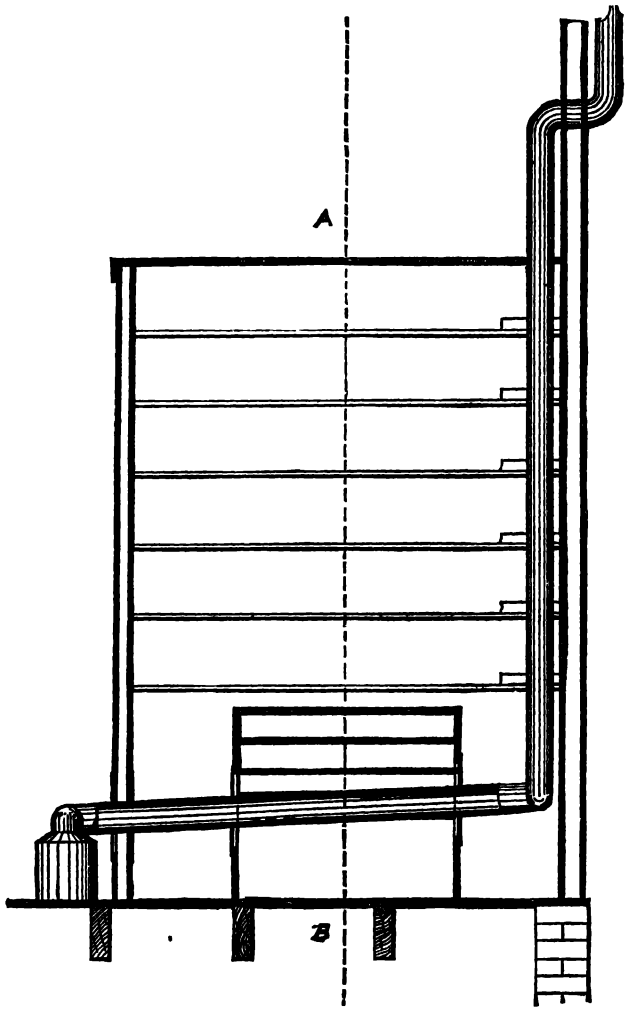

FIG 16.

Receptacles, too small to be called "presses," are sometimes used on a small scale; these are described and figured in many

journals and books; one designed by Mr. W. England is, perhaps, as good as any.

A drying-room will be found far superior to smaller receptacles. If any apartment provided with thorough ventilation and means for entirely excluding every speck of light can be found, plates will dry in such a room, even if it be only ten or twelve feet square, much more quickly than in any box, or even cupboard. Dry air, in a constant and vigorous current, is the required agent for desiccation. Heated air may be used to create a draught, but products of combustion, as from burnt gas, oil, or coal, must on no account be allowed to enter the drying receptacle. While drying, the plates are usually placed on drying-racks, or they may be made to lean against upright spars, with the film turned away from any direction whence dust might come. Plenty of room, as well as plenty of air-current, is required.

Leveling Slab.—As the plates are coated with a warm and liquid solution of gelatine, which sets in a firmer jelly when cold, and as the plates must have an even film of the emulsion, it is necessary to have a level table whereon to lay the plates after they are coated until the gelatine sets. And as it is advantageous to cause the gelatine to set as rapidly as possible, this level table should be cold. A slab of thick plate glass, slate, or marble is generally used, and it is necessary to have means of leveling the slab. One of the writers uses the large, thick, marble slab of a wash-hand-stand, leveled with screws from below. As emulsion usually gets accidentally upon the back of the plate, and causes the plate not only to be unlevel, but to stick to the slab, it is well to stretch strings or piano wires tightly across the top of the slab.

Apparatus for Mixing, Cooking, and Washing the Emulsion.—For mixing the emulsion any vessel may be used that will stand heat and will not in any way chemically affect the emulsion. Glass beakers must be very carefully handled, and vitrified stoneware jars are preferable; glazed earthenware must be avoided. We figure an article, known as a "shut-over jar," which we find admirably suited for emulsion operations; the price is trifling, and the jars are practically

light-tight, though we do not unnecessarily expose them to light. Flasks or bottles should be of glass, so that we can tell whether they are clean or not.

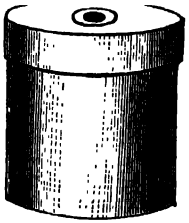

FIG. 17.

Some appliance is needed in order, at a certain stage, to break up the emulsion which has set into a jelly, and this appliance must, if metal, be of "noble" metal—silver, gold, platinum, etc.; or it may be of ivory, ebonite, etc. Frequently the jelly is forced through a piece of coarse canvas, which must be thoroughly clean. Sometimes the jelly is forced through a silver wire mesh by means of a plunger working in a cylinder.

For washing the emulsion a hair sieve will be handy, as described later, or a tea-pot may be utilized, as also mentioned later. Mr. Henderson, of London, provides the most satisfactory emulsion washer we have seen, but we have not space to describe or illustrate it here. An operation superior, in our estimation, to washing is that of "centrifugal separation," remarks on which we must also reserve.

CHAPTER IX.

GELATINE-BROMIDE EMULSION.

PART I.

To Make a Slow Gelatino-Chloro-Bromide Emulsion, suitable for subjects with which shortness of exposure is no object. The exposure for this emulsion will be about the same as that for an ordinary "wet-plate."

a. Gelatine—Nelson's No. 1 ..... 60 grains

Soak in

Water ..... 6 ounces

for a few minutes. Add

Potassic bromide ..... 275 grains
Potassic chloride ..... 40 grains
Ten per cent. dilution of strong hydrochloric acid in water ..... 25 minims
b. Silver nitrate ..... 400 grains
Water ..... 6 ounces

Remarks on the above, which will apply throughout our chapters on emulsion-making. *Potassic bromide* is frequently found alkaline. Such must at once be *rejected*. *Slight* acidity no harm. The same applies to *potassic chloride*. The amount of argentic chloride resulting from the above quantity of potassic chloride is very small, but the color of the image seems to be improved by the presence of the chloride. Hence we recommend this emulsion for lantern-slides (see Chapter XXX.)

Nelson's No. 1 gelatine is generally used for the emulsification on account of its purity, but it is not, on account of its softness, so well adapted for forming the bulk of the gelatine in the finished emulsion. (*vide* "*c*.")

The *water* may be good tap-water, but we prefer *distilled.* The *silver nitrate* is obtainable of the utmost purity at a proper price, and from a proper source.

The ingredients of *a* being all mixed, heat is applied till all are melted.

It is well now to prepare *c.*

c. "Hard" gelatine, as Heinrich's, or Nelson's "X Opaque" ..... 600 grains
Water to cover it.

This gelatine should be previously washed once or twice in distilled water to which a drop or two of ammonia is added; but there is to be no ammonia in *c* when actually used.

Emulsification.—Put *a* into a large vessel, capable of holding at least five times the measure of *a.* Heat both *a* and *b* to 150 deg. Fahr., and take them into the dark-room, which, from this stage, must be "safely" lighted (see previous remarks.) Shake *a* vigorously in its bottle till it froths, and pour into it a *small* quantity of *b.* Shake vigorously, and go on, little by little, pouring *b* into *a*, shaking vigorously each time, till the whole of *b* is mixed into *a*, and *a* is in a complete state of froth. Rinse out *b* with a *small* quantity of water; pour into *a*, and shake for two or three minutes. *a* will now be a creamy emulsion of gelatine and silver chloro-bromide. A cover is now placed on the vessel containing *a* and *b* mixed, or, failing a cover, the emulsion is by other means kept warm for about an hour, being well stirred several times during that time. Then *c*, being melted by heat, gently applied, the emulsion is mixed with it, and the two thoroughly incorporated by stirring vigorously. The whole should be heated to about 140 deg. Fahr., and is then placed aside to cool and to "set." In very hot weather it may be reluctant to set, or it may refuse, in extreme cases of heat, to set at all. In this case cold or even iced-water may be required to make it set. The jar containing the now complete but unwashed emulsion, may be placed in iced-water till the emulsion sets into a stiff jelly.

Emulsification is conveniently performed sometimes in a manner suggested by Mr. T. S. Davis. The silver nitrate of

b is added in the dry crystallized state to *a*, the water of *b* being added at first to *a*. In this case, the crystals of *b* are added all at once to *a*, and vigorous shaking goes on till the crystals are no longer heard clinking in the vessel containing *a*.

Washing is necessary, as we have hinted, to eliminate the bye-product of decomposition, which, in this case, is potassic nitrate; this salt, if left in the emulsion, would probably crystallize on the film; but luckily it is soluble in water, while our sensitive silver haloids are not soluble in water. We, therefore, only require to let water reach the soluble nitrate in order to dissolve it, but the *crux* is to ensure the water reaching the nitrate through the mass of repellant gelatine. Our plan is to break or cut up the emulsion jelly into very fine fragments or shreds, and to allow water to percolate for a considerable time through and among these fragments. There are several methods of breaking up the jelly. It may be removed from its jar with a silver spoon or spatula, or a clean ivory, bone, or ebonite paper-cutter, and placed on a piece of canvas with a large mesh. The canvas is then gathered up at the corners, so as to form a bag, the bottom of which is held under water, while the top is twisted up tighter and tighter, till the jelly oozes out into the water, in long, fine threads. We frankly own this operation is not to our taste. We prefer to cut the jelly into small cubes, place these in a cylinder of glass or vulcanite, having at its end a mesh of silver wire, into the other end fits nicely a plunger, which we force down upon the jelly, till the latter oozes out, as before, in long threads, into water kept (or naturally) cold. Either of these operations may, with advantage, be repeated later, to insure more complete washing.

The shreds of jelly may be received under water in a hair-sieve, which is lifted occasionally during the washing. The sieve may sit in an ordinary china basin. If the washing be performed with running water, and the sieve be occasionally lifted and the basin emptied, the washing should be complete in an hour. The threads may be received in an earthen teapot, a piece of muslin tied over the top, and water run in through the spout for an hour. For years we used the teapot

for washing, and found it answer well. The water should not be of higher temperature than 65 deg. Fahr.; lower is preferable.

The threads, being washed, may be gathered into a muslin bag, and squeezed, to remove superfluous moisture. Or the bag, being of ample size, may be whirled round the operator's head energetically. In any case, not much water must remain, or there will be a danger of the finally-melted emulsion being too thin. Finally, add to the emulsion, in a jar, one and a half ounce of the following:

Alcohol	1 pint
Thymol	100 grains

The emulsion now only requires to be melted by heat, and filtered through swan's down calico, or some similar medium, when it is ready for coating plates.

A Rapid Gelatine Bromide Emulsion by the Boiling Process.—In this case much greater sensitiveness is obtained by boiling the emulsion in presence of only a small proportion of the gelatine used in the last process for emulsification. Gelatine is decomposed by boiling, and loses its power of setting, so that the less we can use during the boiling the better. Moreover, boiling in the presence of a chloride is apt to produce fog, and further, the color of the image, in a process used solely as this is, for the production of *negatives*, is of no moment. The addition of an iodide is found to give greater clearness to the plates prepared with the emulsion, so in this process we replace the chloride of last process by an iodide.

a.	Potassic bromide	320 grains
	Potassic iodide	20 grains
	Gelatine—Nelson's No. 1	60 grains
	Water	6 ounces

Mixed as before, and slightly acidified with hydrochloric acid as before.

b.	Silver nitrate	400 grains
	Water	6 ounces

As before.

c.	Gelatine—hard, as before	500 grains
	Water to cover it.	

Washed as before.

If *a* be alkaline, fog will supervene. If too acid, long boiling will be required to produce great sensitiveness.

Emulsify precisely as before, but after emulsification, instead of placing the emulsion aside to cool gradually, place the vessel containing it in a saucepan of hot water. If emulsification was conducted in a glass flask, the emulsion should at this stage be put into a "shut-over jar" (*vide supra*), and the jar, with its cover on, put into the saucepan, or other covered vessel of water; the water is then to be boiled for a certain time, the jar standing in it. It is impossible to say how long the emulsion is to be "cooked" in this way. The only way to tell when to stop boiling is by examining the color of the emulsion, spread out in a thin, watery film, on a piece of glass.

Immediately after emulsification the emulsion should be stirred with a slip of glass, and the glass examined by aid of a flame of gas, or an oil lamp. (Of course the emulsion in the jar must be kept covered if the examination take place in the dark-room). The emulsion will show a dark orange, or even ruby color at first, but as boiling progresses, the color will gradually become more blue, until, at last, it is distinctly blue. The emulsion at this stage has acquired fair sensitiveness. If we desire more than this, we may go on boiling as long again as was required first to obtain the blue tint. But when the boiling is continued long after the blue tint is reached, the dangers of the process come in, and extravagant boiling will result in granularity and utter fog. The microscopic test is also valuable as an aid to the color test. If the emulsion on the strip of glass used for stirring (which should be pretty frequent, at intervals of say ten minutes) be occasionally examined under the microscope, the same power being always used, it will be noticed that as boiling is continued, the "grain" of the emulsion becomes coarser and coarser, and practice will enable the worker to use the microscope as a valuable aid to the color test.

After the boiling is judged to be sufficient, the emulsion is cooled to 140 deg Fahr., added to *c*, and operations are the same as those given for the slow emulsion.

CHAPTER X.

GELATINE-BROMIDE EMULSION BY THE AMMONIO-NITRATE PROCESS, AND PRECIPITATION BY ALCOHOL.—CENTRIFUGAL SEPARATION.

In the process known as the ammonio-nitrate process, boiling of the emulsion is dispensed with, and in place of the boiling is substituted a system of keeping the emulsion at a medium temperature for a certain time, but in a condition of strong alkalinity. As a general rule, it may be stated that a high degree of sensitiveness is more easily obtained, and the results are more equal, by the ammonia than by the boiling process; while, on the other hand, the opinion is common, if not universal, that the general quality of a boiled emulsion is superior to that of an ammonia emulsion.

The defect most frequently attributed to emulsion made by the ammonio-nitrate process, is a propensity to "green fog," a disease not easy to describe, but easy to diagnose from the name when once it is seen. The formula we now give will, we venture to state, give an emulsion of the highest sensitiveness when required, and will none the less be free from fog, and will stand without fogging an unusual amount of "forcing" by alkali in development. The system, as will be seen, may be described as a compromise between the ammonio-nitrate process, where the silver is entirely "converted," and the boiling process, wherein the gelatine used in cooking is practically destroyed, and, so far as possible, rejected.

A. Ammonium bromide..... 270 grains
Potassic iodide ..... 20 grains
Gelatine—Nelson's No. 1..... ..... 60 grains
Water..... 10 ounces

B. Silver nitrate crystals..... 250 grains

D. Silver nitrate..... .... 150 grains
Water..... 1½ ounce
C. Gelatine—hard, as in last chapter..... 400 grains

C is "converted" into ammonio-nitrate thus: The silver nitrate being fully dissolved, strong liquor ammonia is added to the solution slowly, a little at a time at first, and latterly drop by drop. At the first additions of ammonia, a dark precipitate is formed, but as the additions go on the precipitate at last is re-dissolved and disappears. The vessel should be well shaken towards the end, or its contents well stirred; and in order that the progress may be seen, glass should be the material for the vessel. As soon as the precipitate is entirely re-dissolved the operation is complete.

D requires no remark further than that the proportion of gelatine finally allotted to an emulsion seems to make very little difference to its qualities. A *very* large quantity of gelatine slows an emulsion slightly, but allows of more "forcing" in development.

To Emulsify.—Raise *A* to a temperature varying from 100 to 160 deg. Fahr., according to the sensitiveness required in the final emulsion. The higher the temperature the more sensitive ought to be the emulsion. Even 180 deg. Fahr. is permissible, and will give an exceedingly sensitive emulsion, but there is a danger of fog, and, probably, the plates will require great care in working, even if actual and irremediable fog be avoided. A temperature of 100 deg. Fahr. at this stage will give quite a slow emulsion, probably; 160 deg. Fahr. will give a plate as rapid as most so-called "extra-rapid" plates in the market. To insure thorough solution and mixing of the ingredients of *A*, the temperature should be raised to 150 deg. Fahr., anyhow; and if 100 or 120 deg. Fahr. be the temperature desired for emulsification, the solution may be allowed to cool to the desired point. As it is evident that temperature is the crucial point in this operation; as, clearly, a small bulk of solution will cool more rapidly than a large bulk, and as regularity of result is desirable, a large quantity of water should be heated to the desired temperature in a covered saucepan—a gallon or two, but always the same quantity—and in this the

jar containing *A* is to be immersed till *A* takes the desired temperature. *B* is now added, with shaking, to *A*, as in last chapter. Next, *C* is added, cold, little by little, with vigorous stirring after each addition. Of course, the emulsification must be done in the dark-room, and with special precautions as to light, for this emulsion is pretty sensitive, from its very formation. After the whole of *C* is added, the entire bulk must get a vigorous, or even violent, shaking, for two or three minutes, and is then covered and put in the covered saucepan for two hours. Beyond two hours it is dangerous to go, and after that time it is well to help the cooling, by placing the jar containing the emulsion in cold water. When the temperature has fallen to 70 deg. Fahr., the gelatine, *D*, is placed, dry, in the emulsion; or *D* may be washed, if it is a greasy or otherwise impure sample, with water containing a trace of ammonia; this washing should be done quickly, and the water squeezed entirely out of the gelatine before it is put into the emulsion. *D* having been allowed to soak for about half an hour in the emulsion, the heat is slowly raised to *not over* 110 deg. Fahr., preferably 100 deg. Fahr., when the whole of the gelatine ought to be in a liquid state. Stir well, cool quickly, and allow to set in a stiff jelly. This may be washed, as in last chapter, or may be precipitated for washing.

Precipitation by Alcohol.—Silver bromide is insoluble in alcohol as in water; gelatine is soluble in water but insoluble in alcohol. So, if an emulsion containing gelatine be poured into alcohol, the gelatine will form a clot, the water being removed from it, and along with the water will be removed a great proportion of whatever soluble salts it contains—as nitrates, in this instance. In the ordinary washing process, we have but little control over the quantity of water which will be absorbed by the gelatine, so that, under certain conditions, our final emulsion is too watery, and the following difficulty arises: If, during the "setting" of the gelatine on a coated plate, the silver bromide is allowed to sink through the gelatine down to near the glass or other "support," the quality of the plates must evidently be damaged; if the emulsion be very watery, this sinking will surely take place, and the coarser the "grains"

of the silver haloid, the more surely and more rapidly will this detrimental settling take place. The danger and the damage increase in direct ratio with the sensitiveness of the emulsion, or the grain-size of the silver haloid. Again, when we are dealing with exceedingly sensitive emulsion, the drying of the plates is a process fraught with danger of fog, and the more prolonged the drying the greater the risk of fog. Moreover, as a very sensitive emulsion is more transparent than a less rapid one, a thicker coating of the former than of the latter is required to give a robust image. We need surely add no further arguments in favor of a *small* quantity of water in the finished emulsion; and by the washing process the quantity of water is a factor more or less beyond our power to regulate, while, by precipitation, it is reduced to the minimum. Some authorities advocate the precipitation method, because, by it the emulsion acquires a greater "covering power," in other words, because less emulsion is required for each plate; the claim is well founded, though we would warn our reader against stinting the quantity of emulsion allotted to each plate. The precipitation process is certainly commendable for very sensitive ammonio nitrate emulsions. The practice follows:

Take a jar fit to hold at least four times the quantity of emulsion to be treated; into this place ordinary commercial alcohol, in quantity two or three times as great as the quantity of emulsion. The quantity of alcohol varies according to (1) the quality of alcohol, *i. e.*, the quantity of water in it; (2) the temperature of the alcohol and of the emulsion. The higher these temperatures the more spirit required. Cool the alcohol to 40 deg. Fahr., and let the emulsion be as cool as possible, consistent with fluidity, and alcohol two and a half parts to emulsion one part ought to suffice for complete coagulation.

The spirit being placed in the larger vessel and the emulsion about 90 deg. Fahr., the latter is poured in a very fine stream into the former, stirring being kept up with a glass rod all the time. Clots will form, some sticking to the glass rod, some to the sides and bottom of the jar. When no further *coagulum* is formed, the whole clot is to be pressed hard into one lump, over which a few ounces of fresh alcohol

should be poured. We have now a comparatively small, dense mass of gelatine-clot containing all the silver salts, while the large vessel contains nearly all of the water and of the bye-products. The clot still requires a careful washing. Tear it up with the fingers, or cut it with scissors into *very* small pieces, which are to be placed in water to be changed frequently during twenty-four hours, or the pieces may be washed in the sieve or teapot, as in last chapter. Light should be entirely excluded during all operations where it is not absolutely essential, and in any case the light used must be of the "safest."

When, after washing and "dripping," this emulsion comes to be melted up, it will be found to be much smaller in quantity and thicker in consistency than the batches made by our previous methods. It should, after solution by heat, and the addition of alcohol and thymol, as before, be made up with water to at least twelve ounces.

Separation by Centrifugal Force.—By this process, which, we admit, entails extra and rather expensive apparatus, not only is the messy and tedious, and, at the best, uncertain process of washing done away with, but all uncertainty and irregularity in the components, and consistency of the finished emulsion, are entirely eliminated. Decomposed gelatine, and its too frequent concomitant—fog—are practically banished, and in various respects the ultimate quality of the emulsion is reduced to a matter of weights and measures. The process is applicable to all qualities of emulsion, but unless the principles be understood, the practice is certain to be conducted wrongly, and inevitable trouble and possible failure will arise.

The emulsion, after "cooking," whether by the boiling or by the ammonio-nitrate process, is placed in a vessel which is caused to rotate at a very great speed on its own axis. By the law of centrifugal forces, given a liquid (as water) containing substances not in solution (as silver bromide, iodide, etc.), the liquid being caused to rotate rapidly in a vessel also rotating, the solids not in solution will fly outwards from the centre of rotation with force and velocity directly as their density. The larger the diameter of the rotating vessel—*i. e.*, the longer

the radius of revolution—the less is the speed of rotation required to produce a given centrifugal force ; *vice versa*, the smaller the diameter of our vessel, the more quickly we must cause it to rotate to produce a given effect. The whole theory is exceedingly interesting, but we cannot follow it out here.

The machine used in Great Britain is figured here, and is made by Messrs. Watson, Laidlaw & Co., of Glasgow.* This figure shows the smallest size made. It was, indeed, specially designed for amateurs and experimentalists, and the "drum" is so constructed as to be used in daylight. Larger sizes are

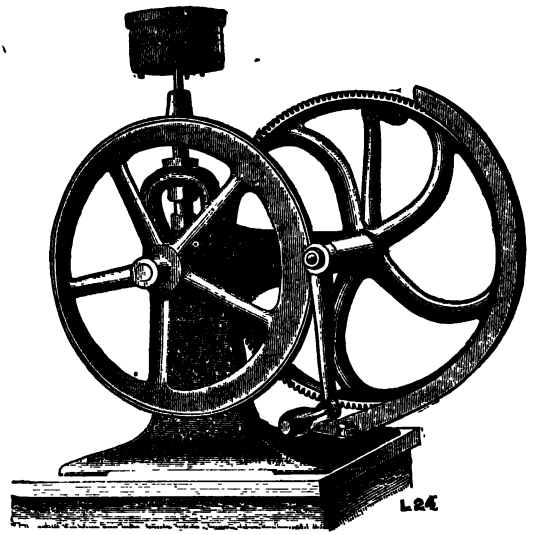

FIG. 18.

made open at the top, for use in the dark-room, and the larger sizes may be driven by steam. Into our small size (4½ inch "drum") we can only put 10 or 12 ounces of emulsion at a time, but into the larger open sizes emulsion can be poured in enormous quantities as separation proceeds, for the solids stick to the sides while the liquid keeps running out. The whole apparatus must be accurately made to insure steady running and high speed, and the "drum" is made of metal heavily

* The Eastman Company are now agents for these machines.

silver-plated. In our little machine the drum can be made to revolve about four thousand times per minute without undue muscular exertion, and, as a rule, three minutes at full speed suffices for our purpose.

It is evident that the denser our grains of silver haloid, and still more, the more completely our gelatine is decomposed and has lost its viscosity by cooking, the more completely will our solids (the silver salts) separate from the gelatine. So it is that the more sensitive our emulsion, by cooking, has been made, the more quickly and the more markedly is our separation accomplished.

We place our cooked emulsion in the "drum," which is the name given to the revolving vessel, the emulsion being at a temperature of not less than 100 deg. Fahr. We start the machine slowly till we have attained the highest convenient speed, and that speed we keep up for not more than three minutes, unless we are using a very slow emulsion. There should be at least four grains of gelatine in each ounce of emulsion actually in the drum. If there is a larger amount of gelatine, no harm will be done, only separation may be a little more protracted. Whatever gelatine is present, during separation, is practically entirely rejected afterwards, and we believe that decomposed gelatine is *entirely* rejected, which, indeed, is one of our strongest claims for the process.

There is not much fear of underdoing the separation, but there is much fear, and we believe a frequent habit, of overdoing it. We cannot account for, we can only state, the fact that over-separation leads to a thin, weak, and even foggy emulsion. Our separation must, therefore, be regulated by the sensitiveness (grain-size) of the emulsion, quantity of gelatine present, and temperature. The larger the grain, the less the proportion of gelatine, and the higher the temperature, the less violent or prolonged must be our separation. If we find we are getting into thin, weak, or foggy emulsions, we may either separate less, or add (say) twenty grains per ounce of gelatine before separation. It has been recommended in case of thinness, etc., to re-emulsify for a time with a small quantity of a soluble nitrate, but we deprecate any such plan. If our emul-

sion is thin, etc., we simply count it a failure, and try again, with greater precautions than before; either more gelatine or less separation.

The separation process must be stopped very gradually to prevent "scour" inside the drum; that is to say, to prevent the liquid, whirling round inside, from washing off the silver salts sticking to the sides of the drum. If the drum fits loosely on its spindle it will stop slowly of itself, if not the motion must be regulated down to a standstill with the handles.

Separation being complete, the drum is carried into the dark-room, and opened with an apparatus which accompanies each machine (for the lid will be very tightly jammed.

The liquid in the middle is carefully poured out into a beaker, where it may be preserved for examination. A little cold water is put into the drum, and gently carried round it, and lastly poured out. In the drum nothing remains but our silver haloids, bound together to the side of the drum by a trace of normal gelatine, and we know precisely what we have to deal with. If we are making a twelve ounce batch of emulsion, as last described, we take 400 grains of hard gelatine, as Nelson's X Opaque, soak it for a time in cold water, ten ounces, and with the soaked gelatine, a little at a time, we mop the drum out, till nothing is left on the sides. This must be carefully and thoroughly done; and when separation has been very complete, as with a very rapid emulsion, long separated, a piece of clean flannel may even be required to remove the solid substance from the sides of the drum. We do not, with our small drum, and a small batch of emulsion, such as described, like to find the solids sticking very tightly to the drum; this a sign of over-separation. Where large quantities of emulsion have been separated, and where the operation has been protracted, the stuff is always in close adherence to the drum, especially that next to the sides.

Our soaked gelatine is now covered with a mass of gray silver bromide and gelatine; alcohol is added, as before, and heat gently applied, during which the bromide and the gelatine must be most thoroughly incorporated by stirring, or even switching. We have now a batch of emulsion of which we

know the ingredients to a fraction. Decomposed gelatine is entirely absent, and with it red fog and other plagues frequently accompanying washing processes.

A plate may be coated for test at once, but it is much better to let the emulsion cool and set at least once before use. Each subsequent melting of an emulsion increases its rapidity to an appreciable extent; too many meltings may fog it.

A word or two on the quality of gelatine used for the bulk of the emulsion. An acid gelatine is not adapted for giving the highest sensitiveness to the plates, and an alkaline soft gelatine is apt to frill or melt in hot weather. We try to steer clear of these defects by using either a "hard" aluminated gelatine washed in alkaline water, or a "soft" gelatine treated with chrome alum added with the alcohol at the last stage. But once the emulsion becomes dry, in presence of alum it cannot again be dissolved, so it is necessary to add the alum only to such quantity as can be used at once.

CHAPTER XI.

COATING PLATES WITH GELATINE BROMIDE EMULSION, DRYING ETC.

THE glass used for coating with gelatine emulsion must be quite clean, but need not be polished to such a degree as is required for wet collodion. But when we come to the operation of coating the plates, a considerable difference will be found between coating a half-dirty and a well-cleaned plate. Plates that have been used before should be bathed for some days in weak acid, one part of hydrochloric or nitric acid to twenty of water. If the film previously on the plate was gelatine, washing in hot water should follow. In any case the plates should be bathed for a few minutes in a hot solution of washing soda, and then well washed under a tap. Next, a creamy mixture of whiting and water is made, rubbed with a clean pad of cloth or flannel all over the plate, and set aside till the whiting is dry and easily dusted off. It should be dusted off, special attention being given to the edges of the plate, and the plate finally polished with a clean, dry cloth. The plates are then racked or laid in a pile till required. If the plates be rinsed over with a weak solution (one per cent.) of chrome alum carefully filtered, frilling will be obviated in the hottest weather (Henderson.)

Coating.—The emulsion is to be melted by heat, but at the time of coating the temperature should not exceed 110 deg., or 120 deg. Fahr. at the very highest. So long as the emulsion will flow readily and not set on the plate with inconvenient haste, it can hardly be too cool. If the weather is very cold the plates may have the "chill off," but anything like heating them is a source of danger. What we have to avoid is the setting taking too long, and, consequently, the silver

bromide sinking through the gelatine to or towards the glass plate. The bromide should be, so far as possible, kept in the upper stratum of the film.

The "setting-table," with its slab of marble, glass, or slate, being arranged dead level, and being within reach of the operator's hand, while he stands at the coating table; the emulsion jar being placed in a considerable quantity of water of the proper temperature, and the light being arranged so that the operator may easily examine the film, all is in readiness for a start. The emulsion, if not previously filtered, must be filtered now, and this may be done in several ways. Perhaps the simplest way is to use, for coating, an earthen, ware tea-pot, having in place of a lid a bag of swan's-down calico, supported by either a wire hoop or an elastic band around the top of the pot, and the bag dipping down to the very bottom of the tea-pot. The tea-pot is placed in the hot water, and all the emulsion is poured into it through the bag before it is poured upon the plates, or the emulsion may be filtered through swan's-down calico into an open-mouthed jar in the hot water, and a silver ladle used to pour the emulsion upon the plate. As a novice is sure to be at a loss how much emulsion to put on each plate, we recommend a silver ladle with a "lip" and a wooden handle—an ancient "toddy ladle" is the article we mean—or a ladle may be made on the old pattern so as to hold a given quantity. Our ladle for plates 10x8 holds just an ounce, for 7x5 or 8x5 just half an ounce. It is impossible to regulate the quantity exactly, as "a little" is usually run off the plate in some cases, and much depends on the quality of the emulsion and the purpose for which the plates are intended. The emulsion must be much thicker on the plate than would appear, to a beginner, necessary; thinly coated plates have of late promised fair to damage the reputation of all concerned.

If the plates are well cleaned, and the emulsion in good order, the coating should be possible almost as with collodion; but if the emulsion has any tendency not to run evenly over the plate, the finger in one case, or the bottom of the ladle in the other, may be used to guide it over the plate. The spout

of the teapot or the lip of the ladle are to be brought close to the plate; the emulsion must not be poured from a height, else bubbles will form. The emulsion is to be poured nearer the centre of the plate than when collodion is used, but still not right in the centre. If too much emulsion is on the plate, the excess is to be rejected by a quick and short "tipping" of the plate over a clean and separate jar, placed in the hot water; nothing like "draining" is permissible, as the film would be too thin. The plate may be held in the fingers, but a pneumatic holder (Fig. 13) is superior to the hand. The operator must not mind if a little emulsion flows over the edge, he should have a large flat dish below his hand, to catch any such overflow. We do not know at what rate plates *can* be coated by hand, but we usually expect to coat two 10 x 8 plates per minute.

To test whether each plate has a sufficient quantity of emulsion, we examine the plate, after it has set, by a gas or lamp flame, behind clear ruby glass. If we can see the shape of the flame, the plate is too thinly coated for negative purposes at least.

The plate is laid on the level cooling slab, as quickly as possible, after an even film has been obtained on the plate in the hand. The sooner the plate sets after this the better. Three minutes should suffice for the setting; if five minutes are required, ice must be used to cool the slab. As a rule, except in the very warmest weather, our plates are set at the end of two minutes, and sometimes very much sooner. To ascertain whether the gelatine is set, or not, a corner of the plate may be touched with the finger, but in no case must a plate be lifted before it is set; a plate raised from the level when just setting, or partly set, is a plate ruined.

As soon as the setting is certainly complete, the plates are dried in a drying-box, press, or room, as already described.

Drying should not take less than five or six, nor more than eighteen or twenty hours. Twelve hours will be found a suitable time. When once the plates are in the drying receptacle and shut in, the door must not be opened for many hours—not until the plates are expected to be dry—nor should there

be any, even temporary, change or check of the draught, as these things will surely lead to "drying-marks," which are beyond cure, and very unsightly wherever they appear. If plates take longer than thirty-five to forty hours to dry, drying marks may be looked upon as almost inevitable. Heat may be used to provoke a current of air, but heated air should not reach the plates, still less, as we said before, any burnt air.

Packing Plates.—When the plates are *perfectly* dry they may be placed in plate-boxes or packed in boxes of cardboard. The plates should be packed face to face, and between each pair of faces should be put a piece of *pure* tissue-paper the full size of the plate, kept for some days beforehand in the dark, and absolutely dry. It is no use to pack carefully away blemished plates, which would only lead to disappointment at critical junctures. The plates, as they leave the drying-box, should be examined, the good ones packed carefully for special work, the blemished ones placed aside for experimental work, of which too much cannot be done.

CHAPTER XII.

THE CAMERA IN THE FIELD.

To do full justice to this heading a long book, instead of a short chapter in a little book, would be required. We must, however, exercise our ingenuity, and try in a brief chapter to give such hints as may enable any intelligent reader to make a public appearance with his camera, and without "shame and confusion of face." As indoor photography at the best presents certain difficulties of technique not likely to be overcome without some practice, we propose to assume that the first set of photographic operations by the tyro will be conducted out-of-doors. In most cases a friend is the victim first immolated on the altar of photographic ambition; but let us warn our gentle reader that there is no surer way to jeopardize friendship, or to bring contempt on ourselves, than to try our prentice photographic hand on a human subject. The best subject, if we could only persuade our reader to take our advice, is something in the nature of a bust or a carved object of some sort, placed in a well-lighted situation out-of doors.

But, to save space, let us suppose our first attempt to be made on a landscape: a foreground, let us say, of bushes, a house or a pool of water in the mid-distance, and, about one hundred yards away, a clump of trees. The sun must be neither straight behind nor right in front of us, but slightly behind the camera on one side or the other. We shall suppose that a dry plate is to be used, in which case we have with us a dark-slide containing a plate, which slide we always keep carefully shielded from strong light in a case of some sort. American cloth does well for the cases, and a number may be painted on the glazed outside of the cloth, so that we know what slides we are going to use.

First, we set up our tripod, the leg-points on solid ground, not on stones, or bits of wood, which may move away and overset the camera; the triangle, or tripod head, nearly level. We fix our camera to the tripod head in the usual way, screw home our lens, tie or button upon the camera the "black-cloth." One leg of the tripod stand is to point to the view, the other two to stretch to right and left of the operator, the ground-glass about the height of the operator's mouth. With our head under the cloth, we now look at the image on the ground-glass; ten to one it is not arranged anything like as we require it. The first thing to do, if not already done in opening the camera, is to get roughly the focus, which is done with the rack and pinion of the camera. The first step toward arranging the view as we wish it on the ground-glass, is to take the two legs to right and left of us, one in each hand, leaving the front leg firm in the ground, and regulating the height, aspect, and level of the camera, by the two legs in our hands. The ludicrous public exhibitions, such as are too often seen, will be entirely obviated by this system of grasping two legs, and using the front one as a pivot. Having, after this manœuvre, planted the camera firmly once more with the view approximately on the ground-glass as desired, any further slight alterations may be made by slightly shifting one leg at a time. By means such as these the camera should be got as nearly level as the eye can judge. The camera may be twisted on its screw from side to side, so that the worker may study the composition of the picture at various angles. A beginner is sure to be greatly puzzled by two things: 1st. The fact that the view is seen upside down on the ground-glass. 2d. The unexpectedly lovely coloring. To both of these he will become habituated by practice. The color is a matter of very great import, however, and is apt to puzzle the most experienced; for the very colors that look so charmingly bright on the ground-glass, are the very ones that ordinary photography renders as shadows, viz: yellows, reds, and greens.

Perhaps, even yet, the arrangement of view on the focusing screen is not to our mind. We have several "motions" yet in reserve. The front of the camera may be raised to cut off

foreground, or get into the picture the top of the house or of the tree. Tilting the camera is only recommended as a last resource, raising the front must be tried first. Having got the view as nearly to our taste on the ground-glass as possible, we insert a medium-sized "diaphragm" or "stop" in the lens, and focus carefully with a Ramdsen, or other eye-piece, or with the naked eye. If the insertion of the stop shuts out too much light, and makes the view appear too dark, remove the stop, or substitute a larger. In focusing, attention should be chiefly directed to the chief object, or "motif" of the picture, and that, as a general rule, should be neither in the centre, nor near one side. Possibly it will be found impracticable to get foreground and distance in decent focus at one time, this will be, to a great extent, cured when a small stop is inserted, and after a little practice the swing-back may be used to meet this difficulty, but we deprecate the use of the swing-back by a beginner. Many workers focus on the foreground, paying no attention to the distance whatever, but trusting to stops to put all right.

The focus being adjusted, we have next to determine what stop to use in the lens. Practically the issue lies between three stops $\frac{f}{16}$, $\frac{f}{22}$, and $\frac{f}{32}$. A larger stop than $\frac{f}{16}$ is seldom used for landscape, and a smaller than $\frac{f}{32}$ is seldom needed. Of course, the smaller the stop, the sharper the focus, and the longer the exposure. In Chapter III. we pointed this out, but we repeat that $\frac{f}{22}$ requires twice the exposure of $\frac{f}{16}$, and $\frac{f}{32}$ twice the exposure of $\frac{f}{22}$. (We omit decimals). If there is anything moving, or likely to move, in our view, we must use the largest stop that will give reasonable definition; while the larger the distance through which our view spreads, from front to back, the smaller the stop required to insure reasonable sharpness.

We most earnestly urge not only the beginner but the more practised hand not to muddle among too many stops. Practically we use but two stops, $\frac{f}{16}$ when we must expose quickly, $\frac{f}{32}$ when there is no hurry. In a few cases, as in a very dark glen, where the exposure with $\frac{f}{32}$ would be very considerable, we sometimes use $\frac{f}{22}$, but this is very rare in landscape work. The photographer has quite enough of varying circumstances

beyond his control without varying operations within his command.

If the subject includes parallel vertical or horizontal lines, as in architecture, some further considerations require notice, and the following remarks apply particularly to cases where the architecture either fills a large portion of the plate or falls near the edge of the picture. In such a case the first necessity is that the camera shall be dead level. But, possibly, the whole of the building will now not "come into" the plate. The first expedient is to go as far away from the building as possible. Failing that, if the top of the building will not come into the field, the front of the camera must be raised as far as it will go without letting light into the camera. Failing that, the vertical position of the plate may be tried, by reversing the back or turning the camera on its side. If this is not satisfactory, the camera must be tilted upwards, always supposing we have only one lens. A shorter focus lens might, of course, remove the difficulty; but tilting the camera upwards will at once cause the straight lines of the building to be "distorted," and in that case we *must* use the swing-back. The lower part of the swing-back must be drawn out, or the upper part pushed forward, till the ground-glass hangs vertical—parallel, that is, with the lines of the building—and in this case a very small stop is required, for reasons into which we cannot enter here.

The Swing-back is very frequently totally misunderstood and shamefully abused, the reason being that photographers do not know, or at least fail to realize, that the swing-back has two uses totally distinct from each other. The uses of the swing-back are: (1st) that suggested a few lines higher, viz., to prevent distortion when the camera is tilted, and (2d), to aid in getting into simultaneous focus a near object and a distant one. On (1) we have said all that seems necessary; on (2) a few words may not be wasted. The focus for an object close to the lens is, as everybody must have observed, further back or further from the lens than the focus for an object at a considerable distance away; so that with the ground-glass hanging vertical when a distant object is in focus

the image of a near object is in front of the focus and blurred. If we focus on the middle distance, or on an object (say) fifty times the focus of the lens distant from the camera, both the distance and the foreground are out of focus, the distance on the ground-glass being behind the best focus and the foreground in front of its best focus. Plainly, therefore, if our swing-back works on its centre, as every swing-back ought to do, and if we pull the top of the swing-back backwards, we shall also push the bottom of it forward, so that the middle distance will *remain* in focus and the foreground and far distance will each find its proper focus. With a central-swing this is plain enough, but with a swing-back working from the top on a pivot at the foot, we are very apt to make the general focus far worse than it was. With such a swing-back, which is usually a swinging of the whole back of the camera, we must either focus on the distance, and then pull back the upper part till the foreground is focused, or we must pull the top towards us first, and try to focus thereafter, a very awkward and uncertain proceeding at the best. The first use of the swing-back—to prevent distortion—necessitates the use of a small stop; the second use, to a great extent, obviates the necessity for a stop, or, at any rate, permits of the use of a larger stop. In all cases the focus should be examined after the use of the swing-back.

We shall leave consideration of what would naturally follow here, viz., exposure, until we have touched briefly on a few other circumstances frequently met with in the field.

It is well to have as few detached articles as possible when going into the field. The tripod screw should either be let into the head, so as not to come out unless purposely removed, or it should be tied to some part of the stand. The stops should not only be tied to the lens (if Waterhouse stops are not fixed in the lens tube), but they should be riveted together in such a way as to allow the one required to be turned aside from the others when it is used. The lens cap may be tied to the lens by raising a small portion of the velvet lining the cap, boring a hole through the leather, passing a bit of catgut through the hole, knotting the end inside the cap, and then replacing the velvet with glue over the knot.

It is, of course, necessary to avoid exposing the same plate twice. Various devices are used to render this mishap impossible. In America a shutter is used for the dark slide, having on one side the word "exposed," in large letters; after exposure this shutter is replaced with the legend outwards. A device is used in England whereby the shutter, once drawn and closed, cannot be again drawn without set purpose and special operations. A beginner during a big day's work is pretty certain to "double expose" a plate now and again, nothing but care and deliberation can prevent it, unless some mechanical device, such as suggested above, is used. When a roll-holder is in use, one very often forgets at the critical moment whether the paper has been rolled off since last exposure, and very painful doubt harasses the worker. We recommend that the rolling be performed immediately after each exposure is made. This is the time when the mental strain is over, and often there is a hurry when the next exposure draws near. Dust has no business to get into a roll-holder, and if it does get in it will do as much damage to an exposed as to an unexposed surface of film.

Everyone should carry a note-book, and note in it every exposure made. Books ruled for the purpose with suitable columns are to be had, but probably an unruled book is quite as good, for frequently the ruled columns do not allow of enough space being filled in special cases. Under the head of "remarks" we include a description of the nature and chief characteristics of the view, the points we wish to bring out, the nature of negative required; and with such details we sometimes fill half a page of any ordinary pocket-book.

To test a camera for "light-tightness" put a lens in its place, a stop in, and the cap on. Place an ample black cloth over the back of the camera as near the ground-glass as possible. Place the dark cloth over the head and draw it tightly around the neck so as to prevent any light entering the camera from behind the operator. The ground-glass being turned away or removed, take the camera up in the hands, gaze earnestly for at least a minute into the interior of the camera in a blaze of sunlight, or (even better) near a strong gas or lamp

flame. Holding the camera in the hands and the face close to the open camera back, turn the camera in every direction, up and down, to the right and left, over on one side, then on the other, always close to the light, if artificial. Any small hole will soon be detected. We have repeatedly found new cameras defective in this matter. The stop-slit of most lenses lets in light; this is a piece of gross carelessness on the part of the makers, and must be remedied by a broad rubber band with a short slit made lengthwise to take the finger-piece of the stop.

The advantages of sliding legs for the tripod are found out not only when working on very uneven ground, but in certain other cases where the camera ought to be very low. Where there is a large exposure of foreground objectionable or uninteresting, as the bed of a river or the water of a lake; or where we wish to emphasize height, as of waves or mountains, the camera can hardly be put too low. For such views it is frequently advisable to place the camera so near to the ground that we require to sit or even lie down in order to focus.

Photography of interiors presents so many exceptional phases that it may almost be called a separate process. As a rule, the camera requires to be mounted to a considerable height for this work, and here again sliding legs are useful. Frequently the floors of edifices are slippery, and the sharp metal "shoes" of the tripod will not grip to floor. The sloping-marble roof of Milan Cathedral was the most slippery place with which we have ever dealt; we overcame the trouble by placing under our tripod feet thick discs of leather wetted previously. Corks, into which the sharp points of the legs are stuck, frequently answer the purpose.

For cases of exceptional difficulty, as for instantaneous "shots" from and at moving objects, there are so many devices to be found in the market that it would be hopeless for us to attempt to describe them. We refer to Detective cameras, and a host of "view-meters" and "finders," many of them sufficiently ingenious to catch the dollars of the amateur, if not the images of the moving objects they are intended to catch. Of "finders," some are practically useful, we may

mention one, called in America, the "Waterbury," and in England the "Argus," which fairly answers its purpose.

For "focusing and finding" simultaneously, no device that we know is of any value, except such as amounts practically to a second camera, furnished with a second lens of the same focal length as the lens in the camera proper. True, the secondary, or "finding and focusing," camera is generally smaller than the working camera; an example of this is found in the small telescope suggested by Mr. J. Traill Taylor. This telescopes fits along the top or side of the camera, and opens out as the camera opens; and the lens of the telescope is of the same focal length as the camera lens but of much simpler and cheaper construction.

Another suggestion made lately is to erect on the front of the camera over the lens another lens of equal focus, to turn the ground-glass of the camera up so that it may stand vertically over its usual position. The "finding" lens will cast an image on the erect ground-glass, which image will be visible under the black cloth, if not without it. When these "finders and focusers" are being used, the shutter of the dark slide is, of course, open, and the instantaneous shutter set for work; so that when in the "finding" arrangement the object is seen in the desired position and focus, the exposure is made with the instantaneous shutter in the usual way.

CHAPTER XIII.

EXPOSURE AND DEVELOPMENT GENERALLY TREATED.

At the end of this book will be found a table compiled for the purpose of assisting the beginner to form an approximate idea as to how long he should expose a plate under various circumstances; but it must be clearly understood that this table is intended merely approximately correct, and by no means to be taken as infallible, or as a crutch, to be depended upon by the worker of experience. Nothing but practice can ever teach the proper exposure, and if our table should cause any reader to use it, or any other "table of exposures," as other than aid to the tyro, we should regret having given it. The table, however, obviates the necessity of our giving further special hints for any cases coming under such heads as will be found in the table. The old rule is to-day just as good as the day it was first enunciated—"Take care of the shadows, and the lights will take care of themselves."

A "good technical negative" is a very elastic phrase; still it is a useful one. Our negative must first be such as will give a "good print." A good print is one that will justly represent the aspect we wish to portray. Whatever else a negative may be, it must be clean, and must be within certain undefinable limits of density and thinness. All the details visible on the subject must certainly be present in the print, and "clear glass" ought to have no place on a negative, whatever others may say.

Luckily for the artistic side of photography, it is not the case that there is only one exposure and only one development which will give a perfect negative. A brilliant negative may be quite as perfect as a tender or soft one; and if we are

to claim any art for photography, we must be able to produce at will a good negative of any desired kind, brilliant or soft, "plucky," or "harmonious."

Exposure and development hang together. One is useless without the other; one may nullify the other; one may emphasize the other; we may produce many different aspects of a view by various negatives—all *good* negatives.

Our next remarks will be devoted to showing how various aspects or qualities may be produced on various negatives—all good—by various treatments, all equally scientific.

There is a minimum exposure, the least that will permit of the production of a good technical negative. There is a maximum exposure, the greatest that can, without abnormal development, be given without ruin to the technique of the negative; and there is a normal exposure midway between the two, what scientifically may be called "the correct exposure," though, artistically speaking, there are many correct exposures. Taking the normal exposure as our standard of comparison, we say.

1. Long exposure leads to softness, harmony, effeminacy.

2. Short exposure gives brilliance, vigor, hardness.

Now, turning to development, we define normal as that which will, with a scientifically correct exposure, give a scientifically perfect negative. Again we take "normal" as our standard of comparison, and we say, *cæteris paribus:*

Strong or short development gives softness, harmony, effeminacy.

Weak or long development gives contrast, vigor, hardness.

(There are, we admit, marked exceptions to these statements.)

Super-normal pyro in development gives contrast, hardness.

Super-normal alkali in development gives detail, harmony.

Super-normal restrainer in development gives hardness, want of detail.

(See chapter on development of gelatine bromide plates, to which these remarks are intended to apply.)

These statements are all to be taken as general.

By attending to the above suggestions the reader may

acquire a certain amount of control over the quality of his negatives; he may learn not only how to produce certain effects, but how to avoid certain dangers. If on his subject he find violent contrasts beyond what he wishes to portray, as is often the case in snow scenes and dark wooded glens, he will get a hint not to under-expose nor to use a supernormal quantity of restrainer. If he has a wide, monotonous expanse of landscape, he will be warned not to over-expose nor to over-dose his development with alkali.

Where a subject contains masses of shadows and masses of high lights in over-violent contrast, and where there is fear of the lights being seriously over-exposed while the shadows are being, according to the old rule, "looked after," the cap of the lens, or a "flap shutter," may, with great advantage and a little practice, be used to shade the light parts while the shadows are being exposed.

CHAPTER XIV.

DEVELOPMENT OF GELATINE BROMIDE PLATES.

Alkaline Pyrogallol Developer.—In this developer the pyrogallol, pyrogallic acid, or "pyro," is used on account of its power of absorbing the oxygen of the water with which it is dissolved, and thus leaving the hydrogen free to combine with part of the haloid silver salts in the film. Hydrochinon, another substance similarly used, acts on the same lines. The alkali, always required with the pyro developer, acts as, and is called, the "accelerator" of the action of the pyro. The "restrainer," consisting usually of a soluble bromide, is used to prevent too great rapidity of action, and to obviate the danger of development or fog in unexposed parts of the plate. The action of soluble bromides as restrainers is a matter very imperfectly understood, and as we have nothing to do with theories here, we confine ourselves to saying that the soluble free bromide acts much more forcibly as a restraint upon the portions not acted upon by light than upon those portions of the film which have received light action. The larger the dose of free soluble bromide the larger may be the proportion of the alkali without danger of fog.

As accelerators, any of the alkalis might be used but for certain inconveniences not directly connected with the process of development. There are but four alkalis commonly used: Ammonia, sodic carbonate, potassic carbonate, and ammonic carbonate. To these we might add hydroxylamine.

Ammonia.—Aqueous solution of ammonical gas. This, used as an accelerator, has the advantage of great vigor, and we claim that with it, *under suitable circumstances*, a negative may be produced, perhaps a shade superior to the best that can be got with any other alkali. But, unfortunately, many plates

now on our markets, especially those produced by the ammonio-nitrate emulsion process, have a strong tendency to green fog when treated with the ammonio-pyro developer. And the ammonia solution being very volatile, it is next to impossible to calculate the precise amount of ammonia present in any quantity of the "liquor ammoniæ fort.," sold as such, and stated to have the specific gravity ·880. As a matter of fact, liquor ammoniæ of so low specific gravity as ·880 is extremely scarce, and, even if procured, would very soon lose much of its gas if the bottle were opened a few times. At specific gravity ·880 the solution contains only 40 per cent. of ammonia. Consulting the table of Carius (given at the end of this book), we find that at a specific gravity of ·92 the liquid contains 20 per cent. of gas; so that if we wish to measure very accurately the quantity of real ammonia we are to use, the best plan is to dilute whatever ammonia liquor we have till our specific gravity test shows ·92, and then to use double the quantity we shall give throughout our formulæ, which are based approximately on "·880 liquor ammoniæ."

Sodic and Potassic Carbonates are not volatile, and not prone to produce green fog in use; however, they give off carbonic acid, itself a restrainer, so that with these carbonates, and also with ammonic carbonate, we use less soluble bromide or none at all. The sodic carbonate gives density *par excellence*, the potassic salt, perhaps, gives a little extra detail. Carbonate of ammonia (ammonic carbonate) is remarkable for its power of giving density, but it acts very slowly, and, both as a solid and in solution, it is unstable. Nevertheless, it deserves more attention as an alkali for development than it receives, as a rule.

Increase of pyro, up to a certain limit, produces increased density; increase of accelerator increases detail and also density, provided that the line where fog begins is not passed. Increase of restrainer protracts the time required for development, is apt to produce thinness, and to prevent detail from appearing if the plate is the least under-exposed.

We are often astonished, and always puzzled, by the ridiculously intricate formulæ sent out by plate makers as instructions

for working their plates to the best advantage. We seldom dream of making up stock solutions in the terms of these empiric formulæ, but we always endeavor to analyze the formulæ so as to find out, as nearly as may be, without a long string of "repeating decimals," how much of each reagent each formula contains. From this calculation, generally troublesome, we gather what are the qualities we may expect from the plates in question.*

There is no virtue beyond that of convenience in ten-per-cent. solutions, but ten-per-cent. solutions will be found to answer all purposes. We shall state the method of making such solutions for alkaline developers, and thereafter we shall give formulæ only in terms of the reagents actually employed.

Pyro Solution, "10 *per cent.*"—If we took an avoirdupois ounce of pyro, dissolved it in water, and made the bulk up to nine fluid ounces, we should have approximately a 10 per cent. solution, and every ten minims would contain one grain of pyro. But pyro dissolved in this way would oxidize, and in a very short time become useless. Two drams of citric acid added would improve the keeping qualities, but we give two methods far superior, the first due to the ingenuity of Mr. H. B. Berkeley, the second a modification, by ourselves, of a formula first promulgated by Messrs. Mawson & Swan, of Newcastle, England:

SULPHO-PYROGALLOL (BERKELEY.)

Take

No. 1. Sodic sulphite, best obtainable...4 ounces avoirdupois
Water, hot.....about 6 ounces

dissolve; add citric or sulphurous acid till the reaction is distinctly acid. Add to one commercial ounce of pyro, dissolve, filter, make up with water to nine ounces. Label: "Pyro. 10 per cent. 10 minims = 1 grain pyro."

Take

No. 2. Potassic bisulphite..... ½ ounce
Water.....about 5 ounces

dissolve, pour into an ounce of pyro, make up to nine ounces,

* See the table compiled by Messrs. Clarke and Ferrero.

filter. Label: "Pyro. 10 per cent. 10 minims = 1 grain."

(Messrs. Mawson & Swan formulate "Meta-bisulphite of Potash." We know nothing about this salt, which is not listed by any manufacturer we know, except the above firm; we have used the meta-bisulphite, and also ordinary bisulphite, and can distinguish no difference in the result.)

BROMIDE SOLUTION. 10 PER CENT.

Take

Potassic or ammonic bromide.....1 ounce avoirdupois
Water.....about 7 ounces

dissolve, make up to nine ounces. Label: "Bromide. 10 per cent. 10 minims = 1 grain."

AMMONIA SOLUTION. 10 PER CENT.

Take

Liq. ammonia, .880..... 1 fluid ounce
Water.....9 fluid ounces

Label: "Ammonia. 10 per cent. 10 minims = 1 minim liq. ammonia, .880."

Make, in the same manner as the bromide solution, 10 per cent. solutions of sodic and potassic carb., or proceed as follows, for a solution which can be recommended:

Take

Sodic carb. crystals not "anhydrous"..½ ounce avoirdupois
Potassic carb.....½ ounce avoirdupois

dissolve in water, and make up to nine ounces. Label: "Carbonates. 10 per cent. 10 minims = ½ grain sod. and ½ grain pot. carb."

A normal developer may be thus:

1. Pyro..... 2 grains
Ammonia..... 2 minims
Bromide..... 1 grain
Water to..... 1 ounce

Or,

2. Pyro..... 3 grains
Sodic carbonate.....12 grains
Water to..... 1 ounce

Or,

3. Pyro..... 4 grains
Potassic carbonate.....20 grains
Water to..... 1 ounce

Or,

4. Pyro..... 4 grains
Potassic and sodic carbonates.....16 grains
Water to..... 1 ounce

To each of the developers (2, 3, and 4) may be added, if there is the least fear of over-exposure, one-half grain of bromide, but it must be remembered that with the carbonate developers the restraining action of bromide appears disproportionately vigorous.

These are by no means the limits in either direction of our use of the accelerators, nor are we restricted to any particular time for duration of development. The carbonate developers in particular will go on acting for a very long time, but, as a rule, the action of the ammonia developer is sooner exhausted, and a little more ammonia may be added, the quantity varying with the requirements of the case and the capability of the plate for tolerating ammonia. If bromide be also added, a very considerable quantity of ammonia is permissible. It may be said that the above developers ought to fully develop a plate properly exposed in three minutes, but in the case of of ammonia a perfect negative may result even if we require to add another minim or two of ammonia to each ounce of developer.

Soluble bromide, as we have said, has a strong tendency to prevent density, and where, on this or any other account, the use of a large quantity of soluble bromide is contra-indicated, use may be made of citrates, as first pointed out by, we believe, Mr. G. W. Webster. The citrates may be made up in 10 per cent. solutions, thus:

Sodic or potassic citrate.....1 ounce, avoirdupois

Dissolve in

Water and make up to..... ..9 ounces

As there is some doubt as to which citrate is the better, we use both :

Sodic citrate..... ½ ounce, avoirdupois
Potassic citrate..... ½ ounce, avoirdupois
Water to.....9 ounces

For cases of very great over-exposure, four grains of citrate may be used for each minim of ammonia in the developer, but, as a rule, two grains will be found sufficient. The citrate, combining with the ammonia to form ammonic citrate, allows density to increase, but prevents the appearance of further details.

For cases of over-exposure we decrease the alkali, increase the bromide and the pyro. With the carbonates the addition of water frequently has the desired effect. For gross over-exposure, whether known before development, or discovered after development is started (see below), the citrates may be used with ammonia.

Under-exposure, if it can be met at all, will be met by reducing the pyro and bromide, and increasing the alkali and the water where there is fear of over-density.

Subjects presenting violent contrasts of light and shade, as interiors, dark glens, etc., will be developed into the best negatives, if the exposure has been full, by considerably reducing the pyro and bromide, increasing the alkali, as far as is safe, and developing lightly, that is, not carrying the developing action so far as for a normal subject.

Subjects monotonous, or devoid of contrast, may be treated with an extra dose of pyro and bromide, just enough alkali to secure detail, and a development carried to a super-normal degree.

The variations that can be made in alkaline pyrogallic development are simply innumerable; in fact, its "elasticity" is its strong point of advantage over the "ferrous oxalate." (See lower.) The ferrous oxalate has a certain amount of range also, but in this matter it is distinctly inferior to the alkaline process.

When the worker is undecided as to whether his exposure has been approximately correct or not, the simple and evident

plan is to develop slowly at first till the quality of the image slowly growing can be examined. For this purpose the normal developer may be made up, but with only one half of the alkali, the other half being kept apart till the image either refuses to appear, or appears over-exposed, as will presently be explained. Or two complete but totally different solutions may be prepared, one strong in restraining, the other in accelerating, reagents. Thus, No. 1 may contain: pyro, 4 grains; bromide, 3 grains; ammonia, 2 minims to each ounce; and No. 2 may contain: pyro, 1 grain; bromide, 1 grain; ammonia, 4 minims. The plate is treated with No. 1 first; if no image appear, and if it is not hopelessly under-exposed, No. 2 will probably put it right, if it is over-exposed No. 1 will probably save it, if anything can, or citrate may be added when the details are all visible; or if in No. 2 details begin to appear too quickly, we can put the plate back into No. 1 till density is gained.

As plate after plate is sometimes, for economy's sake, developed in the same solution, we must point out that in such cases not only is the pyro oxidized, and rendered inert, but fresh bromide is formed, and also the ammonia decreased by the action between the liberated bromine and the ammonia, ammonia bromide being, in fact, formed, or sodic, or potassic bromide, as the case may be.

The Hydrochinon Developer was introduced some years ago, by Captain Abney, but for some time fell into disuse; it appears to be once more attracting notice. The substance, hydrochinon, does not keep well (Eder), and in our experience does not, as a developer, work well with ammonia. But with a carbonate it will, when fresh, be found to give fine results. We give the formula of the discoverer, and in a later chapter will be found another method of using it for another purpose.

1. Hydrochinon..... 10 grains
   Water..... 10 ounces
2. Carbonate of potash, a saturated solution, in water.

To each ounce of No. 1 is added 1 dram of No. 2, and about 10 drops of 10 grains to the ounce solution of chloride of sodium (common salt.)

Possibly some workers may prefer to keep their carbonates and citrates in more concentrated solutions than the 10 per cent. we have suggested. To make a 30 per cent. solution of carbonates, for instance:

Take

Sodic carb	1½ ounce avoirdupois
Potassic carb	1½ ounce avoirdupois
Water to	9 ounces.

Label: "Carb. Solution, 30 per cent.—10 minims = 3 grains carbs."

By way of example of the use of these 10 per cent. and 30 per cent. solutions, let us suppose we wish to make two normal developers as above in quantities of 3 ounces each.

For our so-called Normal Ammonia Developer, No. 1 (page 87) take:

10 per cent. pyro	60 minims
10 per cent. ammonia	60 minims
10 per cent. bromide	30 minims
Water to	3 ounces

For a normal, such as No. 4 (page 88):

10 per cent. pyro	120 minims (= 2 drams)
10 per cent. carbs	480 minims (= 1 ounce)
or: 30 per cent. carbs	160 minims (= 2 drams 40 minims)
Water to	3 ounces.

If to the former we wish to add 1 drop of ammonia per ounce of developer, then add

10 per cent. ammonia	3×10 = 30 minims

The *Ferrous Oxalate Developer*, largely used on the European continent on account, perhaps, of the quick-printing quality of the negatives produced. Ferrous oxalate is a yellow salt insoluble in water, but soluble in potassic oxalate. By mixing ferrous sulphate with potassic oxalate we not only form ferrous oxalate, but hold it in solution by the excess of potassic oxalate.

Take

1. Potassic oxalate	1 part
Water, hot	3 parts

The oxalate should be acidified with oxalic acid. The water should be free from lime.

Take

2. Ferrous sulphate (protosulphate of iron)..... 1 part
Water, hot..... . 4 parts
Acidify with sulphuric acid.

To make the developer: Pour one part of No. 2 into four parts of No. 1. Do *not* pour No. 1 into No. 2. A little bromide (say half a grain per ounce of the above mixture) may be added in case of known over-exposure; but it is not necessary nor, indeed, advisable in ordinary cases. This developer, also, may be varied within limits, and the best way to get "latitude" of working with it is to make several mixtures of various proportions, as No. 2 one part, to No. 1 five parts; or, No. 2 one part, to No. 1 six parts; and to begin development with the weakest, passing the plate to the stronger solutions as, and if, desired. A *trace* of sodic hyposulphite added to this solution of ferrous oxalate increases its developing activity, but this must be added with great caution, as it often results in catastrophe to the negative.

This developer, once mixed, may be used over and over again so long as it is used within a certain time after the mixture of the two solutions. The mixture, however, may be long preserved by keeping it under a layer of oil, as may be done by the device figured here. The mixed developer is poured in at the top, oil is poured on top of it, the cork is replaced till developer is required, when the cork (and with it the end of the rubber tube), is lowered over a dish, and the developing liquid, of course, pours out. Sometimes, in order to maintain the vigor of this developer, bright iron wire is kept in contact with it.

FIG. 19.

Manipulations of Development.—The exposed plate being removed from the dark slide in the dark-room, should be dusted with a broad camel's-hair brush and laid face upwards in a black developing-dish, such as described in our chapter on apparatus.

The developing solution is then swept over the film in such a way as to cover every part at the first sweep. Plenty of solution should be allowed by the beginner, in order to prevent any part of the film being missed by the first wave of the developer, and so uneven markings being produced; the solution is to be *kept moving* over the film.

In a period varying from ten seconds to twenty-five or thirty, in a general way, the image may be expected to put in an appearance. The period varies considerably, and depends on the quality of gelatine used in the emulsion chiefly, but, of course, this refers to "normal" exposure and developer. If the exposure or developer be far wide of the normal, it is impossible to say how long or how short a time the image may take before it appears. The first appearance of the image under the action of a normal developer ought to be most carefully scrutinized. We consider this appearance by far the best guide to the future regulation of the developing process.

If the image comes up very gradually, almost reluctantly, one detail following another with a considerable lagging in the progress, the exposure has probably been insufficient. The negative, however, *may* be saved by an addition of alkali, and, perhaps, of water; or, the developer may be rejected, the plate washed, and a new developer made up containing less restrainer and more accelerator, in certain cases with less pyro.

If, on the other hand, the high-lights are instantly followed by half-tones, and a gray color appears over the whole film, the plate has certainly been over-exposed. An over-exposed plate, *taken in time*, may almost always be saved, unless the over-exposure is very gross. In bad cases of over-exposure the developer should be instantly rejected, the plate washed, and a new developer made up, containing more restrainer and pyro, and less accelerator.

If, after the application of this, the image still comes up very gray, it is well to allow the details to appear in their entirety, and then to add to the developer a dose of the citrate solution, recommended in the proportion of from two to four grains of citrate to each minim of ammonia. If a carbonate developer is being used, the developer may be instantly watered

on the appearance of the grayness; and if that is not sufficient to allow the high-lights to gain density, a dose of bromide may be added.

With a normal developer, such as any of those we have given, the image, in a case of proper exposure, will begin to appear in from ten to thirty seconds, the high-lights will appear first, but before they have acquired any considerable density, the half-tones will appear, followed in turn by the shadows. The whole process of revelation will be gradual, steady, unhalting. When the density appears sufficient, and when no longer any white, and not much gray, is seen on the face, the plate may be examined by transmitted light, and the back may also be examined, so that the operator may note to what extent the action of the developer has penetrated the film. The back of the plate is no real criterion of anything, except the quality of the emulsion and the method of coating and setting the plate. Combined with examination of the image by reflected and transmitted light, examination of the back of the plate may be of service when the worker knows the qualities of his batch of plates. Experience alone can teach to what point a plate should be developed.

If, in any particular part, details appear reluctant to appear, the developer may be repeatedly poured upon that part from the cup or measure, or a camel's-hair brush may be well wetted with the developer and rubbed over the weak part. We have even dipped the brush in stronger developer in a separate vessel, and with it "locally developed" details.

When the development is judged complete, the plate is well washed under the tap, and either fixed at once, or placed in a strong solution of common alum, and fixed after washing. The object of the alum is to harden the gelatine, and prevent possible blistering, or frilling, in later operations. For the alum bath before fixing no acid should be used, except after ferrous oxalate, when a small quantity of citric, or acetic, acid may be added, though we do not insist on it. If there are grounds for expecting frilling, the plate, after pyro development, may be put into a slightly acid alum solution, straight from the developer; in this case the acid is of use in arresting develop-

ment. As a rule, it will be found advisable not to alum before fixing, as after fixing the negative may be of such a quality as to be better unalumed, *i. e.*, the negative may be slightly thin for printing purposes, and the stain which the alum is partly used to remove might be advantageous to such a negative.

CHAPTER XV.

GELATINE BROMIDE PLATES, FIXING, INTENSIFICATION, REDUCTION, ETC.

THE fixing solution is as follows:

Sodic hyposulphite	5 ounces
Water	1 pint

Ammonia, or ammonic carbonate till the solution is distinctly alkaline. And it must always be kept alkaline and up to strength. After the plate has been in the fixing solution for a certain time, the white (unaltered salts) will disappear from the back of the plate; the plate is at that stage just half fixed, and must be left about as long again to insure proper fixing. If, after a negative has been kept for some time, and, perhaps, printed from a good many times, a yellow-brown discoloration appears upon it, usually starting at or near one edge, that plate was only half fixed, and it is to be regretted that this matter is so frequently overlooked as it is.

After fixation is complete the negative has to be thoroughly washed, and with a glass negative this is not always so simple an operation as might be expected. The plates may be washed in about ten minutes by causing a good rose tap to play on each, but this is not always convenient, so they are either to be soaked for some hours face downwards in a suitable vessel, the water being frequently changed, or they may be washed, a good number at a time, in running water by the aid of an article figured Nos. 23 and 23*a*.

There are a great many apparatus on the market for washing glass negatives, most of them on the syphon principle; as a rule, these are good.

The washing after fixing need not, in its first stage, be so

very prolonged if the alum and acid bath is to be used. But the negative should be well washed and not merely rinsed before it is immersed in the following bath, which may be omitted if the plate was immersed for a considerable time in alum solution before fixing:

Potash alum, solution saturated in cold water.

Citric acid, to each pint of the above, three ounces; or this also may be saturated in the alum solution.

Or hydrochloric acid to each pint of the above double saturated solution, half an ounce.

This bath will harden the gelatine and will remove any stain due to the pyro used in development.

After again washing, the plates are allowed to dry; heat must not be used to hurry the drying. If it is required to dry a plate in a hurry, soak it five minutes in good alcohol, take it out of the dish and, holding it tightly in the hand, whirl it rapidly or wave it quickly through the air. If frilling makes its appearance during the last washing, at once cease washing and plunge the plate into alcohol, leaving it there till the frilling disappears, which may take many hours. If a batch of plates shows a tendency to frilling, alum each plate well before fixing, and after fixing put a good dose of common salt into a dish with water and immerse in it each plate as it leaves the fixer. If the plates frill in spite of these precautions send them back to the maker, they are not reasonably adapted for the purpose for which they were bought, or for which they were sold.

After drying, the negative may or may not be varnished. The gelatine film is quite strong enough to stand the ordinary wear of an amateur's printing; but if there is fear of damp, or of scratches, or if a great number of prints are likely to be required, the negatives may be varnished in the manner given for collodion negatives. A film of plain collodion over the gelatine is a good preservative, and may be followed by a film of varnish. Among our formulæ at the end will be found one for varnish.

Intensifying gelatine bromide negatives is in most hands a very uncertain and dangerous operation; but if the precautions

we shall point out are duly attended to, there ought to be no difficulty. Still, it is much better to make negatives such as are certain not to require intensification, especially as reduction is an operation much more simple, safe, and certain, than intensification.

There must, in the first place, be not a trace of hypo left in the film; if any hypo remain, the negative will be ruined, to a certainty. Various hypo-eliminators are suggested and recommended, chiefly depending on the action of chlorine in one shape or other. We cannot advise the use of any hypo-eliminator except water; some of the advertised articles eliminate the hypo, certainly, but introduce something worse than what they eliminate. Chlorine, at all events, should be avoided.

MERCURY INTENSIFIER.

Mercuric chloride	1 part
Water	20 parts

Of this, one pint. Strong hydrochloric acid, 30 minims. (Due to Mr. Arnold Spiller.)

In this the plate is soaked till the image becomes a pearly white or bright gray color. Wash *thoroughly*. Put the plate into a dish, and sweep over it sufficient of

Ammonia	1 part
Water	20 parts

Or,

Sodic sulphite	1 ounce
Water	1 pint

The former solution gives more density than the latter, but the color of the image produced by the latter is better. If sufficient density be not gained by the first operations, they can be repeated, beginning with the mercury, washing and finishing with the sulphite. The washing after intensification must be thorough.

Reduction of Gelatine Bromide Negatives.—If a fixed and washed negative be found too dense, it may be reduced in the following simple manner, suggested by Mr. E. Howard Farmer, of London, England.

Make a fresh solution of sodic hyposulphite, as for the fixing-bath, but omit the alkali. Make also a strong solution of potassic ferricyanide ("red prussiate of potash.") Place the negative in the hypo for some minutes, and put into a cup or measure a few drops of the ferricyanide solution. Pour the hypo into the measure with the ferricyanide, so as to mix the two well, and then pour the mixture on the negative in the dish. Immediately a reducing action will begin, and the first dose may be sufficient; if the action ceases before sufficient reduction has taken place, add a little more ferricyanide, as before.

"Local" reduction, *i. e.*, reduction of parts only of a negative, may be easily performed by rubbing the parts with a rag, dipped in alcohol. The rubbing must be fairly vigorous and prolonged; but care must be taken not to break the film by over-rubbing, nor by allowing any grit to get between film and rag.

CHAPTER XVI.

DEFECTS IN GELATINE-BROMIDE NEGATIVE.

THE gelatine-bromide process is, like all other processes involving delicate manipulation (especially in semi-darkness) and accurate chemical calculations, liable to defects, and sometimes a worker will produce a defect altogether peculiar to his own manner of working and unintelligible to others. All that can be done in this chapter is to deal with the defects that anyone may fall upon, and that the writers have themselves experienced and seen.

Fog may be due to many causes. It is not difficult to recognize, and hardly needs description, but we may liken it to a general *veil*, of more or less pronounced character, all over the plate. There are two kinds of fog, distinct in nature, appearance, and *rationale*. *Green fog* is, unfortunately, common in commercial plates kept for any considerable time, and is noticed first in the shadows of a negative as seen from the back of the plate. In this shape it does very little harm; but what we take to be a variety of the same fog shows itself as a bronzing, spotty, metallic-looking stain, which usually begins at the edges of a plate and creeps inward, finally culminating in red fog, which is a hopeless calamity to the plate. We have watched the progress of this fog from the inchoate "shadow-fog," through the "bronze-period" "into the region of eternal night." Ammonia aggravates it, and in our opinion causes it; and plates showing a tendency to green fog should be developed with carbonates or ferrous oxalate. Plates even above suspicion of this fog, when they are new, often acquire it if kept in an atmosphere where much carburetted hydrogen gas is burned. Sometimes, indeed frequently, the green fog which appears to be on the surface of the film, can be removed by rubbing the film with a rag dipped in spirits. So far as

we know, Mr. R. W. Robinson first brought this cure under our notice. *Red* fog we have never been able to cure or even to mitigate. We *believe* it is merely an exaggerated form of green fog. In emulsion-making, red fog may be caused by the boiling process in presence of alkali; such red fog may be "separated" by the action of "centrifugal force" (see page 64), which makes it probable that this fog is due to some gelatine combination.

Grey fog may arise from *over-exposure*—the cure is evident, or rather, the means of prevention; *unsafe light* in the developing-room, *camera or dark-room, slide not light-tight; reflections* inside camera or lens-tube. All these can be readily discovered and remedied. Fog may be produced by too long a time being employed for the drying of plates after coating with emulsion, the danger or defect being aggravated in proportion as the drying atmosphere is damp or contaminated with carburetted hydrogen or sulphurous fumes.

To discover for certain whether the light of the operating-room is at fault, one of the plates may be exposed to the light suspected, for five minutes, in contact with a negative or the screen of a "sensitizer." If no image appear on subsequent development, the light is "safe." We have already given a method for testing the camera, etc., for light-tightness. Another method is to place a plate in the camera in the dark-slide as usual, and to draw the shutter, leaving the cap on the lens. The whole is allowed to stand in bright light for a few minutes. On development, fog will show if due to leakage in the camera, or reflections arising therefrom.

Fog may be due to *development*, to overdose of alkali in pyro development, or to alkaline reaction in ferrous oxalate development.

Over-density of the negative may be due to over-development, pure and simple, or to over-forcing in development of an under-exposed plate. In the former case the cure will be found in the method of "reduction" given on page 99. The other defect, where the high lights are dense out of proportion with the shadows, is difficult, if not impossible, to remedy.

Thinness, or *want of density*, may be due to several causes. *Under-development;* intensification will be found more easy in this kind of case than in any other. *Over-exposure;* intensification may be resorted to. *Light fog*, in quantity not sufficient to entirely ruin the plate, will produce a thin image; thus a very dim reflection in the camera, or a moderately unsafe light in the operating-room, while not sufficient to produce a regular fog, will produce a thin image. Thinness may be due to the *emulsion.* If the plate is too thinly coated; if the emulsion does not contain sufficient of the silver haloid; if the emulsion has an over-acid, or a very alkaline reaction; if too much chrome alum be used in the emulsion, and under many other less common conditions, a thin image may result.

Frilling may be due to *dirty plates;* plates *overheated* before coating; an improper *quality of gelatine*, or *want of alum* in the gelatine in very warm weather; *osmotic action* in the hypo, produced usually by a too strong solution of hypo; action of too strong *acids* on the film at some stage, as in the alum bath. Sometimes plates will frill in spite of all that can be done to prevent it, but in commercial products frilling is now happily very rare.

Yellow Stain all over the plate, due to the *pyro*, and occuring especially with the carbonate developers. The alum and acid bath will remove this stain.

Spots.—Small *transparent* spots on the negative are usually due to dust. *Opaque* spots may arise from the quality of the gelatine; we have known immense crops of them produced by iron rust in the water supply. *Circular transparent spots, with sharp outline*, are due to air-bubbles forming in development, or in the emulsion. (See our instructions for applying the developer.) A broad camel's-hair brush may be used to spread the developer over the film in the developing dish immediately after the first application of the developing solution. Some workers soak their plates in plain water before development, there is no harm in, nor need for, this operation with glass plates.

Halation (appearance of "halo.")—Found when objects in

high light and objects in deep shadow are close to each other in the picture, the most frequent examples being the windows in interiors, and branches of trees against a brilliant sky. Halation is due to two causes, which must not be confounded. 1st. *Reflection from the back of the glass plate*, at an angle near to that of "total reflection." This kind of halation may be obviated by using films in place of glass plates, and to a certain extent by "backing" the glass plates with some substances of non-actinic color in optical contact with the glass. *Burnt sienna*, rubbed into a paste with gum and water, may be applied to the back of the plate before exposure, and removed with a sponge before development, or a piece of black "carbon tissue" may be wetted and squeegeed into contact with the back of the plate. A *thin film* of emulsion, especially in the absence of the yellow stain due to iodide, is very apt to give halation. The defect may, to some extent, be removed by rubbing with a rag dipped in alcohol. (See page 100.)

2d. Halation due to *dust in the air*. This is, of course, not true halation, in the technical acceptation of the word, but it is often mistaken for the true halation. Neither the use of a film nor "backing" will prevent this kind of halation, but the same cure may be tried, viz.: rubbing down the over-dense parts with alcohol on a rag.

Various curious markings may be produced by various blunders. *Scummy* marks are over-produced by using too small a quantity of developer, and not keeping the solution in motion during development. *Crape-like* marks occur frequently with certain brands of plates, and seem due to dirty glass plates.

If, during drying of a negative, water is splashed on to the film, a mark will occur which we can neither account for nor efface; the result is a patch *lighter* than the rest of the negative.

Sometimes a bronze-like, metallic-looking scum forms on negatives developed with pyro preserved with sodic sulphite. This may be removed with a rag and alcohol. Whether it is identical with one form of green fog we cannot say.

CHAPTER XVII.

PAPER NEGATIVES AND STRIPPING FILMS.

In the chemical operations of developing an image in gelatine emulsion, there is no difference whether the film of gelatine be on a rigid, permanent support, or a flexible, textile, temporary support, but of necessity the manipulations must be somewhat altered to suit the altered circumstances. The composition of the solutions for developing, fixing, clearing, etc., already given, will answer for paper negatives and films quite as well as for glass plates.

Paper Negatives, wherein the paper remains permanently the support, of which, as a type, we may take Eastman's Negative Films. These may be exposed in cut sheets, for experiment; but vastly preferable are the roll-holders known as the Eastman-Walker. In one of these is placed, with every convenience for exposure, a long band of negative paper, to be unwound for exposure in proper quantity and position, which can be determined by fittings forming essential parts of the apparatus. In Fig. 20 we show the latest pattern of the East-

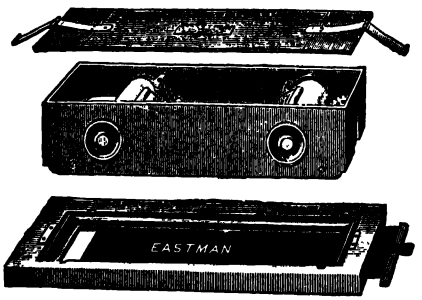

FIG. 20.

man-Walker Roll-holder, and as full instructions are given in various places for its use, we need not waste space in repeating

these instructions. We will, however, give one or two hints, which we think may prove useful, whether "negative films" or "stripping films" are used in this roll-holder. Although the instrument itself registers on the paper the extremities of each exposure, it is well, whenever opportunity offers—during a tour, for instance— to mark in pencil each end of the film as it presents itself when the shutter is withdrawn. This will form a further safeguard, beyond the small punched holes, against cutting up the film in the wrong places. (The necessity for this is much lessened in the new pattern.) When about to develop a spool of exposed films, the inexperienced will do well to cut off one exposure at a time, and develop one before he cuts off another. (The new pattern is vastly improved in this respect, also; in fact, the new design is so superior, in almost every essential point, to the pattern originally introduced, that those who bought the original pattern have a distinct grievance, that, so soon after they had purchased one pattern, another so greatly superior should be brought under their notice, and should excite their covetousness and tempt them to extravagance.)

The exposed length of film for development, being cut off, is immersed in water face downwards for a few seconds, being slidden sideways, if possible, into the water; after the few seconds have elapsed it is lifted face up and either brushed over with a broad hair brush under water, or pulled quickly along the face up under water. This is simply to prevent air-bells. Development follows, then fixing, washing, clearing, washing again. Then the film is squeegeed face downwards to a polished sheet of vulcanite, where it is allowed to dry, and whence, when dry, it ought to strip off with ease, one corner being raised with a knife or other pointed instrument. According to the instructions, the negative should then be rendered translucent by the application of some oily lubricant, such as the "translucine," sold for the purpose. Against this oiling we protest. Printing truly is rendered more rapid, and "grain," possibly, may be slightly eliminated, but without special and highly inconvenient means the negatives so treated cannot be preserved for any considerable length of

time. The best method by far, if the negatives are of any nature, is to leave them as they come from the vulcanite.

Stripping films (also "Eastman") are coming into more and more general use by rapid strides. In this case development, fixing, and washing are precisely as before; but, for evident reasons, the paper being removed finally, the development should be carried a little further, apparently (*i. e.*, as observed in the dark-room), than in the case of glass plates, and considerably further than in the case of paper negative films. The Eastman Company strongly advise the carbonate developer in place of the ammonia—we can vouch for the excellence of ammonia, and other authorities can equally vouch for the carbonates. The films should not be alumed until a later stage; there is no necessity for, and there may be danger in, the alum.

The stripping films, after fixation, are washed; but as they have to undergo several future washings, the first need not be of any very great duration. A plate of glass, a little larger than the film, is cleaned, rubbed all over with powdered talc (French chalk), the talc rubbed apparently all off, and the plate "edged" or coated with a very thin solution of pure India rubber in benzole, also pure. It is then coated with thin, plain collodion, which, when set, but not dry, is washed till the greasy appearance due to the solvents is gone. The film is now squeegeed to the collodion film, blotting-paper laid over the paper film, and a weight applied for at least quarter of an hour, and as much longer as convenient. The paper may even be allowed to dry, but it must not be partially dry, it must be all damp or all dry. After a suitable time has elapsed the plate bearing the collodion and the paper film is placed in water at about 120 deg. Fahr. The tissue is prepared by the makers in this way: The paper is coated with a fairly thick film of soluble gelatine, which is then calendered. The emulsion, rendered totally insoluble with alum, follows. So that when the tissue is placed in hot water, as above, the soluble gelatine melts and the paper can be removed. No attempt must be made to remove the paper until air-bubbles are seen from the back to form under the

paper. The paper when detached is thrown away, the film washed under the tap, and if desired, cleaned in alum and acid, and washed again.

A "skin" (consisting of gelatine and glycerine poured on a glass plate, dried and stripped), is now soaked for a few moments in water, placed on the negative film adhering to the glass plate, the squeegee is gently applied in sweeps to the back of the skin so as to expel air-bells and superfluous water, and the whole is set aside to dry spontaneously. When the film is dry it is coated with plain collodion and again allowed to dry. The margins are then cut round with a sharp point, and one corner raised from the glass, when the whole negative will leave the glass and remain in the hand, a real thing of beauty so far as its own inherent qualities are concerned. The negative film now consists of an image of silver in an extremely attenuated film of insoluble gelatine, strengthened by the skin, and the whole almost hermetically sealed between two strata of damp proof collodion.

It need not be matter for surprise if the beginner find some little trouble in such a series of operations, but a little practice and thought will enable anyone to make a certain success of the stripping operations. The accidents most frequent are:

"*Grain*," appearing in certain parts of the negative. Due to the soluble gelatine substratum being too thin. Remedy: Reject or return at once to the maker all the spools bearing that batch number. This fault has been, by the perseverance and care of the makers, almost or entirely eliminated from all the stripping films we have seen of late.

The *paper refuses to strip* from the film on glass. Substratum becomes insoluble from tanning in prolonged pyro development, or, more probably, the film has been kept too long before use.

The *whole film threatens to leave the glass* in the hot water. Dirty plate, improperly talced, collodion not properly washed, stripping too soon after squeegeeing, castor oil or greasy matter in the collodion, India rubber solution too thick.

Blisters after stripping. Water too hot, acid in "clearing solution" too strong, collodion oily, plate dirty, talcing improper, etc.

After the "skin" is applied and when film is nearly dry, film showing tendency to *jump from the plate.* Skin not enough soaked. In certain cases, especially in hot weather, a little glycerine may be added to the water in which the skin is soaked. The thinner the skin and the warmer the water the less soaking is required; in extreme cases the skin may be simply passed through the water. A thick skin must be soaked till just limp. If the glass plate be not coated or edged with rubber, or if the collodion be too thick, the film may spring from the plate prematurely.

The film, when dry, *refuses to strip* from the plate, a very unlikely cause of failure. Dirty plate, want of talc, or too much left on plate, or the plate too much polished after talcing.

The finally stripped film, if not quite flat, may be placed under pressure after the face has been rubbed with the soft part of the hand to remove the thin film of rubber due to the coating of the plate with rubber solution, if the plate was so coated.

There is no necessity for stripping a film, unless we choose, before a trial print is taken from it. It can be dried after fixing and washing, *but not alumed*, and can be stripped at any future time. But in this case the film must be well soaked in water before squeegeeing to glass plate, and the water for stripping will probably require to be hotter. As a rule, hot water entails no danger to the emulsion, we have stripped in boiling water, but this ought not to be needed, and certainly is not recommended.

In cases where reversal of right and left is a matter of no consequence, as in portraiture in certain cases, the final stripping need not be resorted to. The film, *minus* the paper, can be left adhering to the glass plate in a reversed position, in fact, for certain purposes this is a necessity, while for other purposes it is immaterial one way or the other.

There are other tissues and films on the market, some of which give promise of future excellence, if, indeed, they do not already possess merit. So far as we have seen the failing in these transparent films has been not in the support so much as

in the emulsion itself, which has, in our experience, often been of inferior quality, and carelessly applied. A London firm is now coming into notice with a film which we ourselves introduced to the notice of the firm, the Vergara Film Co. The film in this case consists of gelatine heavily chromated, and is certainly beautifully transparent; of the general qualities of the tissue we have, at the time of writing, had little opportunity of judging.

CHAPTER XVIII.

"COLOR-CORRECT," OR "ORTHOCHROMATIC" PHOTOGRAPHY.

Every one who has had even slight experience of photography must have noticed the fact, that the color yellow, which appears brightest of all the colors to the eye, is rendered on a photographic negative as nearly clear glass, and on a print as nearly black, while the dark blues of nature, so little brilliant to the eye, are rendered as more or less high-lights, dark on the negative, and light on a positive. Clearly this is a defect of, and a reproach to, photography, and any means by which we may more correctly render the visual value of these colors must be welcomed. Great steps have been made of late years in this respect, and greater would doubtless have been made had not researches into the matter been more or less hampered by patents in certain countries.

It is very long since the discovery was made that by photographing certain colored objects through yellow media the color values were more correctly rendered, a certain amount of the actinic blue and violet being shut out by the yellow medium.

This was, indeed, a short step in the right direction; of late much greater strides have been made, for gelatine-bromide films have been produced, actually more sensitive to the yellow and yellow-green of the spectrum, than to the blue and violet. As a rule films are, by treatment with certain aniline dyes, made much more sensitive to the yellow, yellow-green, and even to the red rays than they are normally without such treatment; and the action is further eked out by the use of yellow screens, which further decrease the disproportionate actinism of the blues and violets by partly "filtering out" these portions of the normal spectrum.

It must be clearly understood that the action of the dyes is not merely a staining action; the staining has undoubtedly an effect, *per se*, but the important factor in the matter is the new compound formed by the combination of the dye with the silver in the film, or in the emulsion. Nor must it be forgotten that outside the solar spectrum there is no existing *pure* blue or any other color, and we have, moreover, always to take into account *reflection*. The yellow color of an object may be due to a mixture of colors by no means identical with prismatic yellow; and the light reflected from an object may completely upset all our impressions as to the real color of that object. This reflected white light renders our plates (however we may have endowed them with "color-sensitiveness") *relatively* less orthochromatic by increasing the intensity of the blues and violets.

The substances most commonly used for gelatine plates are eosine compounds, such as the dyes known as erythrosine, rose bengal, and eosine itself, and with these is generally used an alkali, viz., ammonia. The form in which these are used is generally that of a bath applied to the coated and dried plate, but frequently the dye is added to the emulsion in bulk in the liquid state before plates are coated. We shall confine our attention to the process of bathing a ready-prepared plate. Every precaution must be taken to guard against fog as the plates are rendered not only highly sensitive to yellow and orange, but also strongly alkaline in reaction, in which state a plate is always highly susceptible to fog, not only from light, but from every sort of noxious vapor. The light used must be of the deepest ruby color, and, indeed, the less of even that used the better. Certain dyes also fog plates even in darkness.

A plate should be chosen with an emulsion containing little or no silver iodide; we have known as little as three parts of iodide per centum of bromide to nullify our attempts to get a good orthochromatic effect. The plate is first bathed for two minutes in a solution—

Liquor ammonia	1 part
Water	100 parts

Then without washing immerse in

Dye (eosine "B," erythrosine or rose bengal, etc.)	1 part
Water	10,000 parts
Ammonia	100 parts

The most convenient way to arrive at these very dilute solutions of the dye is as follows. Make first an aqueous solution of (say)

Erythrosine	1 part (1 gram, for instance)
Water	1000 parts (1000 c.c. for instance)

This may be kept a considerable time in the dark.

The ordinary 10 per cent. ammonia solution may be used. Then take

Dye (1 to 1000)	1 part
Ammonia (10 per cent.)	1 part
Water	8 parts

Some dyes useful for this purpose are insoluble in water; in these cases alcohol (absolute) may be used for the first solution:

Dye (as cyanine)	1 part (1 gram, for instance)
Absolute alcohol	1,000 parts (1000 c.c., for instance)

Some workers find difficulty in using the alcoholic solutions, as there is a marked tendency to uneven staining of the plates.

Mr. J. B. Wellington, of London, has shown a way to overcome the awkward precipitation that takes place when cyanine is dissolved in water.

Prof. C. H. Bothamley, F.I.C., F.C.S., of Leeds, has done much to elucidate the practice and principles of this process, his writings may be found in files of the *Photographic News*, 1887, and elsewhere. We mention his name simply because it has been prominently brought forward lately, and not at all to the exclusion of others, as Vogel, Eder, Ives, Abney, Schumann, &c.

We have said that in many cases, in order to get the best effect, we require to use a yellow "screen." This may be of yellow glass, but the sides of the glass must be absolutely

parallel. A much better plan is to dissolve *aurantia* dye in alcohol and to mix the alcohol with plain collodion, which is poured upon a talced glass plate, and when dry stripped. A piece of this collodion film may be fixed by any suitable permanent or temporary means over the aperture of the lens diaphragm. But the screen must be used with discretion. The same screen will not answer for all purposes. The more intense the blues with which we have to deal, the darker should be the yellow stain. With artificial light, as gas or paraffin, the screen will probably not be required at all. In such a light the general sensitiveness of the dyed plate will be found very great.

For landscape work, on account of the reflections already mentioned, a very dark-yellow screen is usually required, but, again, it is pointed out that in the yellow or reddish light of approaching sunset a screen is not needed at all.*

It is within the mark to say that in color-correct photography lies the future of the science and of the art.

At the conference of the Camera Club, in March, 1888, Captain Abney read a paper relating to his theories on orthochromatic processes. He recommended the application to the dried gelatine film of collodion or varnish containing certain suitable dyes, but we are not aware of success having followed this practice in any hands, other than those of the Captain, who, indeed, probably used the process for his own special purposes of spectrum photography.

Of all the processes tried by the writers, none seems to them more satisfactory; certainly none is more simple than that last suggested by Mr. Ives, of Philadelphia. It may be stated thus:

In four ounces of absolute alcohol dissolve one grain of erythrosine or cyanine. Soak the gelatine bromide plate in this for a minute. Allow to dry. Wash for a short time in running water. Dry, and use. No alkali is used. The plates

*There is a danger in using a screen too dark-yellow for landscape; in such a case the foliage may be represented in the print as light where the artist intended it for the shadow of his picture.

keep well. The cyanine renders the plates so very sensitive, even to red rays, that these operations, as well as development, must be conducted practically in darkness. The erythrosine formula has proved in our hands eminently satisfactory, the cyanine no less so, but the precautions necessary with it apt to be irksome.

CHAPTER XIX.

STEREOSCOPIC PHOTOGRAPHY.

As we see a natural object with two eyes at once, and as our eyes are about two and a-half inches apart, it is plain that we really see two images from slightly different bases, or points of view; our right eye sees rather more of the right side of the object than our left eye sees, and *vice versa*. Yet our vision and our brain so work together that we do not, *as a rule*, see objects double, but single. Photography, in producing stereoscopic pictures, imitates nature in her provisions for enabling us to see things with a certain amount of roundness or *solidity*, and for enabling us, to a certain extent, to realize the distances between objects on different planes.

At one time stereoscopic photography was a fashion, if not a craze; and when the fashion died out, so great was the reaction that from a position of undue importance, stereoscopic photography fell into a position of unmerited contempt. In England, of late, it has been once more attracting attention, and we think we shall not do amiss by saying a few words on the subject.

The camera used for this class of work is provided either with one lens fitted to a long-range sliding front, so that after one picture is taken the lens is slid about two and a-half to three inches to one side, and another picture is taken; or the camera has two lenses, side by side, their centres distant about two and a-half to three inches, and their foci exactly equal, for which reason they are often called "twin" lenses. Three inches is by no means the limit of separation, for with a distance of only three inches between the axis of the lenses, objects at a distance will not be shown stereoscopically at all; we have ourselves moved the whole camera several feet, with cer-

tain precautions, and succeeding in producing stereoscopic effect, where, without that proceeding, we should have got none. But for near objects, three inches will be found quite sufficient.

If the camera be moved at all, it must be moved only horizontally on the axis of the lens; or, in other words, both views must be taken on the same base-line. Various ingenious devices for shifting the camera in this manner on its stand have been designed.

The usual size of a "stereo" plate is $6\frac{3}{4}$ x $3\frac{1}{4}$ inches, but, so long as the *centres* of the mounted prints are *not over* $2\frac{5}{8}$ *or* 3 *inches apart*, the height need not be limited to $3\frac{1}{4}$ inches; in fact, we have seen very fine stereographs five inches high. Mr. J. Traill Taylor, whose authority on such subjects cannot be impugned, recommends for stereo-work a plate 8 x 5 inches.

A little consideration will show that if the two halves of the stereoscopic picture are taken on one plate, these halves will require to be transposed if the view is to be seen stereoscopically, unless they are purposely transposed on the plate by taking the right view on the left side of the plate and the left view on the right. A camera and slide used to be made for this very purpose of transposing, but, as a rule, cameras now made for stereo-work are "binocular," *i. e.*, consist practically of two cameras, side by side, a division stretching inside the full size camera from front to rear. In cases where a binocular camera is used, the two prints must always be transposed in mounting, unless the two negatives are transposed in printing. The negatives to be transposed may be cut down the centre with a diamond, if glass, or with a pair of scissors, if paper, and may then be printed side by side in the transposed position; but, unless the negatives are trimmed according to the following rules, there is no gain in dividing the two halves.

Some persons can see stereographs without a stereoscope, but probably these persons are few. Certainly most persons require a stereoscope for the purpose. With a "reflecting stereoscope," pictures of almost any size can be seen, but the

instrument commonly used is the well-known "refracting stereoscope." We cannot enlarge on this instrument further than to say that the majority of those in the market are useless. The lenses should be adjustable as to their distance from each other, to suit various pairs of eyes.

The crucial point in stereography is mounting the prints. We shall suppose that the negatives have not been transposed, and that we have to mount a double print, the sides having to be transposed.

First, we have to determine a *base line*. The first trimming-line is to be drawn so that it cuts a given object in the foreground of each half at precisely the same point. The top of the prints is then to be trimmed *parallel* with the base line. Next, the two halves have to be separated and transposed. The pictures are to be mounted so that their centres shall be not less than two and three-quarter inches nor more than three inches apart. In trimming the sides of the pictures, we must, on the print that is to be mounted on the right-hand side, leave more subject on the right than we leave on the right of the left-hand picture; and on the left-hand picture we must leave more of the left side than we leave on the left of the right-hand picture. In other words, we must trim the right picture a little more to the right of any given object appearing in both halves, and we must trim the left-hand picture a little further to the left than we trim the right-hand picture, and still we must keep the pictures exactly the same size, and their centres the distance apart already specified (read "British Journal Almanac, 1887," article of the editor.)

CHAPTER XX.

PART II.

PRINTING PROCESS—PRELIMINARY.

We have so far treated almost entirely of processes for producing negatives, we now come to processes for producing positives, or prints.

Printing may be by "contact" or by "enlargement," or by "reduction"; the image may be "printed out" or "developed," on paper, glass, opal, cloth, etc. Lastly, a print may be on an opaque support or on a translucent support used as opaque; or it may be on a transparent support, as glass ("transparent positive," or "transparency," or "lantern-slide,") or it may be on a translucent support, as an "opal transparency."

The order which we propose to follow is, first, printing on paper with silver salts; second, printing on paper with salts not of silver; third, the processes specially adapted for producing the beautiful and useful positive known as a lantern-slide.

The Printing Frame.—We may once for all dispose of the mechanical operations of printing by contact, they are of the simplest description. The only apparatus actually necessary is a "printing frame," which is merely an arrangement for holding the negative and the sensitive surface firmly together face to face, and for allowing the progress of printing to be observed without danger of moving the two from the position with relation to each other in which they were originally placed. Two kinds of printing frames are Figs. 21 and 22, each typical of a class. Fig. 21 shows the

appearance of the lighter class of printing frame, and this style is usually made to take in its rebate one size of negative

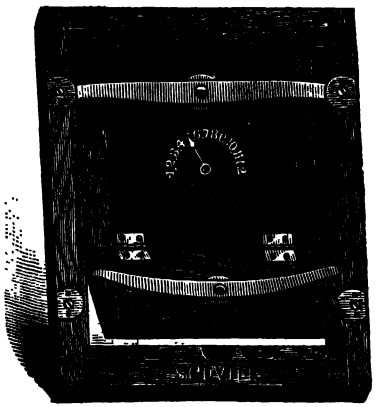

FIG. 21.

only, while Fig. 22 is heavier, being furnished with a plate of glass which ought to be "plate glass," or at least perfectly

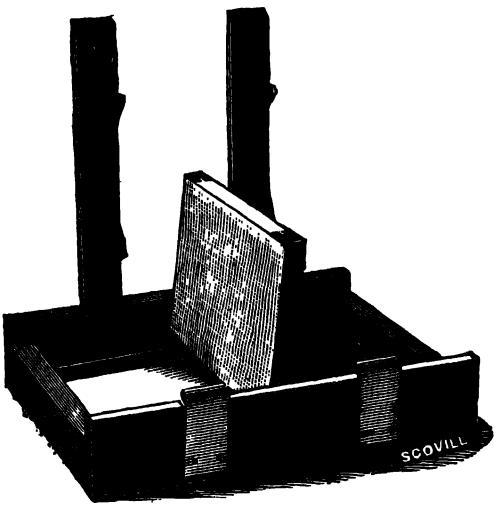

FIG. 22

flat to avoid breakage of negatives. The springs in this latter frame should be strong so as to insure perfect contact at all times between negative and sensitive surface.

The negative is laid face up in one of these frames, the sensitive material is laid face down on top of the negative, a pad, or several pads, of paper, felt, or cloth is placed next the sensitive material, the back of the frame covers the pad, and the frame is closed. It is then placed with its front to the light. The printing-room should be dry but cool.

The back of the frame is hinged so that one-half can be turned back and the progress of printing examined without shifting the position of the other half.

In large sizes two hinges are to be recommended. Indeed, an 8x10 double-hinged printing-frame has often made its convenience felt to the writers.

For printing processes where "combination" printing may be required, special "registering" frames are made; we do not think it necessary to describe these.

CHAPTER XXI.

PRINTING ON ALBUMENIZED PAPER WITH SILVER CHLORIDE.

In this process, paper of specially good quality is, by means of special appliances, coated with albumen (or white of egg), containing a certain proportion of a soluble chloride, usually ammonium chloride. When this is floated on a solution of silver nitrate of sufficient strength, silver chloride is formed by double decomposition and the silver chloride remains in the albumen in conjunction with a certain excess of silver nitrate, a necessary condition for success. The silver chloride blackens on being exposed to light, but there is a further combination which exercises an important influence on our results and on our operations: that combination being one between the silver nitrate and the albumen, and, further, probably between the silver nitrate and the "size" of the paper. The presence of these organic silver salts accounts for much of the beauty and many of the disadvantages of this process.

It would be hopeless for anyone not in the trade to attempt to produce salted albumenized paper of quality comparable to that made by the few firms who produce albumenized paper; we, therefore, shall accept as certain that our reader will purchase for his work paper ready-albumenized and salted. On the quantity of soluble chloride in the albumen depends chiefly the strength of the "sensitizing" bath, and, as a rule, instructions accompany each sample of paper sold.

Sometimes the paper presents a very high gloss, and is called "double albumenized;" this paper is slightly more difficult to work, but the results are by many considered superior.

The sensitizing bath consists of a neutral solution of silver

nitrate, varying from about forty to sixty-five grains of silver nitrate to each ounce of water. A bath of lower grade than thirty grains to the ounce will fail to effect the necessary coagulation of the albumen, but in the other direction we may go far beyond a sixty-five-grain bath. A large quantity of chloride in the albumen and a double albumenized paper indicate a strong bath, as a rule, but the condition of the albumen must also regulate the strength of the bath.

The *time* of flotation necessary also requires consideration. The albumenized salted paper is floated on the solution of silver nitrate; if we do not float long enough we get poor prints, if we float too long we waste silver. We have to utilize all the salt in the paper, and in order to make certain that all the soluble chloride is converted into silver chloride, we use the following pretty and simple test. A solution of potassic chromate five grains, water one ounce, is made, and a drop put on the back of the paper to be timed. The paper is now floated (albumen downwards) on the silver bath, the time being carefully noted; when the originally yellow spot of chromate has become deep orange color, the conversion is complete; this will form a guide to the time required when the serious operation of sensitizing larger sheets is in progress.

We may take as a normal sensitizing bath:

Silver nitrate	60 grains
Distilled water	1 ounce

Tested with litmus, and if acid, neutralized with sodic carbonate. The worker must determine for himself the size of sheet he is to sensitize at one time, and a white porcelain dish, scrupulously clean, will be found the most convenient receptacle for the solution.

As sheet after sheet of paper is sensitized, the strength of the bath naturally falls, as of course a certain quantity of the silver nitrate is converted by the chloride in each sheet, and further, the bulk is also diminished. The latter is of less moment than the former matter; both may be met by making up the deficiency in bulk, with a more concentrated solution than that constituting the bath. Our reserve stock solution may be about 100 grains of silver nitrate to each ounce of water, and

the addition of this in sufficient quantity to keep our bath up to its original bulk will probably suffice to keep it up also to its original strength. The "argentometer" will not here give us correct readings, on account of the organic salts, sure to be present in the bath solution; and we may, to make sure that our solution is *up to* a certain standard, use the following instructive test.

We first determine what is the minimum grade to which our bath may be allowed to fall, the test will inform us whether or not the bath has fallen below that minimum.

We require the chromate solution already formulated on another page. We further require a solution of potassic bromide of one or other of the following standard strengths. In making up the bromide solution we must weigh out the solid bromide, dissolve it in less than an ounce, and then make up to an ounce of water.

For a minimum grade of silver nitrate per ounce of bath.	We make a solution of potassic bromide.	
50 grains	35 grains	To each ounce of bromide solution.
55 grains	38.5 grains	
60 grains	42 grains	
65 grains	45.5 grains	
70 grains	49 grains	

We *fill* a small pipette with the best bromide solution, and put the contents of the pipette into a *white* cup or saucer, and add to it about 20 times its measure of water. We then put in enough of the chromate solution to make this faintly yellow. Having cleaned out the pipette, we *fill* it with the bath solution under test, and we let the bath solution fall, drop by drop, into the faintly yellow bromide solution. As each drop touches the solution at first, a red stain will appear, but will immediately disappear on stirring, but as the dropping goes on a point will finally be reached when the red stain will become permanent, and will not disappear on any amount of stirring. If this critical point be reached just as our pipette is empty, the bath is just about our minimum standard; if the red become permanent before our pipette is empty, the bath is above our standard; but if we have to add

a few drops of the bath after the pipette is empty to make the red disappear, then our bath is below our standard; and with a little practice, by noting how much extra bath solution is required, we shall be able to judge approximately *how much* our bath is below "par."

After a few sheets of paper have been sensitized, the bath solution will become discolored, owing to the presence of organic salts. In this case add to the solution a few drops of a concentrated solution of sodic carbonate till the bath is neutral, shake up, and place in strong day—or sun—light. A black precipitate will fall to the bottom; this is to be filtered out. Thereafter, add a little more soda to the bath and it is ready for use again.

Manipulations of Sensitizing.—Keep the albumenized paper in a place slightly damp, as a cellar, for some hours at least previous to sensitizing. The sensitizing solution is poured into a flat porcelain or glass dish, the depth of solution being not less than half an inch. Bend the sheet to be sensitized into a loose roll, albumen inward, for a moment or two; seize two opposite corners of the sheet with the two first fingers and thumb of each hand, knuckles upward; make the middle of the sheet droop, albumen downward, so as to meet the surface of the solution evenly; lower the ends of the sheet gradually, but without stoppage, till the whole sheet lies flat on the solution. Or one end of the paper may first be brought into contact with the solution, and the rest of the sheet slidden onto the solution. For instance, if the left side of the sheet is to touch the solution first, lower it to the right-hand side of the dish, and slide it gradually to the left, lowering the other parts of the sheet all the time. If in either case the ends seem inclined to rise up, blow them down with the breath or touch them gently with a clean instrument. No bath solution should get on the back of the paper. And in either case, after the sheet lies flat, each corner should be raised in turn and air-bells, if found, burst with a sharp point, as of a quill or silver instrument. We have already given directions for regulating the time of flotation; it will be found to vary from three to five minutes, depending to a

considerable extent upon temperature. Flotation and drying should be carried on by yellow light; naked gas, or lamp light is quite safe.

When the flotation is complete the paper is to be taken by one end or corner with horn forceps or a silver instrument, and being seized in finger and thumb of each hand is to be *very slowly* removed from the bath. It may be drawn over the edge of the dish, or over a glass rod for the purpose fixed over the dish in some suitable manner. The paper is then hung up to dry in a well-ventilated room. It may be hung by two corners by glass clips, or it may be laid over glass rods face upward. The only danger is that the corners drying first may curl inward and damage the wet or damp centre. There will probably be no trouble in this drying matter. A small piece of bibulous paper should be pressed against any corner that shows signs of collecting a drop, and these bits of paper, as well as all filter papers used for silver nitrate solutions, should be laid aside for future reduction with other residues (see chapter on residues, page 182.) When the paper is surface dry, and before it has curled seriously, it may with advantage be laid out flat between sheets of pure blotting paper and so preserved under weight.

Paper prepared in this way will turn yellow in periods ranging from twenty-four to forty-eight hours, unless specially treated in one of the ways to be described presently.

Fuming sensitized paper is a very common practice in America, and it presents, under certain circumstances, indubitable advantages. The process of fuming consists simply in shutting up the sensitized paper in a cupboard with a saucer of liquor ammonia. The paper is hung by clips to the upper part of the press and the ammonia is placed in the lower part. This system is particularly beneficial when the paper is apt to get too dry. Paper fumed in this way is probably even more liable to the yellowing described in last paragraph.

To preserve sensitized albumen paper—that is to say, to prevent the yellow discoloration just mentioned, soak stout blotting-paper in a half-saturated solution of sodic carbonate,

and dry it. As each sheet of paper leaves the sensitizing bath it is blotted with clean blotting-paper, and is immediately thereafter placed between two sheets of the blotting-paper prepared as above, a weight placed on top of the entire lot, and in this state the paper will keep white and good for weeks or months. Sheets of blotting-paper similarly prepared may, with great benefit in results, be used as pads for the printing frame, especially when, owing to bad light or dense negatives, the printing is very protracted.

Ready-sensitized paper is an article of commerce largely used, and being more and more used every day. Its qualities are often excellent, and in use it in no way differs from home sensitized albumen paper. The method of production is supposed to be a trade secret.

Printing presents no difficulties to those who have acquired experience. The critical point is the extent to which the printing should be allowed to go, and nothing but experience will ever teach that. Papers differ and negatives differ in this respect; tastes also differ. We may say, however, that with albumen paper the printing is always to be carried several degrees beyond the depth required finally, as all papers lose more or less depth in the subsequent processes of toning and fixing. "Double printing," "vignetting," and other special manipulations are treated in another chapter (page 133, *et sq.*). After the print leaves the printing frame it is placed aside in the dark, or in safe light, till a sufficient number are ready for the next processes.

Toning.—The paper when it leaves the printing frame is still, of course, sensitive to light and requires fixing; but were it fixed without an intermediate operation, the image would not only be of a most unsightly color, but would be "fugitive" and fade in a comparatively short time. By the process of toning, or "gilding," as it has been aptly called, we give the image not only a pleasant color but superior permanence. Toning consists of either replacing a certain quantity of the reduced silver (oxide?) by gold, according to one theory; or depositing a layer of gold over the reduced silver, according to the theory which appears better founded. The

gold is deposited from an alkaline solution of its ter-chloride, and the toning bath commonly used is known as the "alkaline gold toning" bath. The action changes the color of the image from a rusty red to brown, violet, purple, or blue, according to the color of the underlying substance seen through the gold layer, and according to the thickness and state of division of the gold layer. Thus, in order to produce a rich, warm tone, it is necessary that the image, before toning, shall have a more or less ruddy color, for it is evident that if on a purple or violet ground we superpose a layer of metallic gold, itself black or nearly so, we can never produce a warm blending of color. Thus, in the washing necessary previous to toning, we should endeavor to produce—if we wish warm tones finally—a substratum as warm or ruddy as possible. Moreover, the more gold we can pile upon our image, without giving the image too much of the cold color characteristic of gold in fine division, the greater the chance of permanence for our image; for it is the complicated organic silver compound that causes fading, and not the gold, as may easily be proved by comparing the action of agents destructive to a print—as mercuric chloride—upon a toned and an untoned print.

Following out the above reasoning, we need have no doubt as to our operations in washing previous to toning. Some papers leave the printing frame with a ruddy color; which is accentuated on washing in water. These prints only require to be washed in plain water, till free silver nitrate is removed; three or four changes of water suffice, as a rule, to remove the silver nitrate, the last water should show no sign of milkiness, due to the nitrate, combined with salts, in the water. But these red papers are usually acid, having been "preserved" by a method entailing free acid; and as acid in the toning bath is objectionable, it is advisable to put into the second washing water a small quantity of sodic carbonate. The prints must not convey acid, nor, as a rule, carbonates, to the toning-bath. Prints that leave the printing frame violet must be reddened for a warm tone, and to insure this a quantity of sodic chloride (common salt) is put into the second washing water; but

neither should this substance be allowed to get into the toning-bath. During washing the prints should be kept moving for about ten minutes in each "water," and should not be touched on the face with the fingers. After washing, the prints are conveyed separately to the toning solution. The dish containing this should be white porcelain, and of sufficient area to hold *two* prints, side by side, at least. The solution should be, at least, half an inch deep, we prefer more depth. In the "toner" the prints must be kept moving, and should be, at first, anyhow, face down.

Very many toning-bath formulæ have been suggested; as a matter of fact, the mode of using influences the results far more than the formulæ used. The temperature should not be under 65 deg. Fahr., nor over 75 deg. Fahr. We give two formulæ only, the first is the oldest of its kind, so far as we know, and we are quite certain it has never yet been surpassed for beauty of action, certainty, and keeping qualities.

1. Sodic acetate..... 375 grains
   Water..... 120 ounces

Put a fifteen grain tube of "terchloride of gold" into a large bottle, break the tube in the bottle, and pour in the above solution. Ready for use after twenty-four hours, or may be made ready sooner by using the acetate solution, boiling and using the toning solution when cooled to 70 deg. Fahr. We prefer to allow the twenty-four hours to pass. This solution will keep good for any length of time, provided the gold when used up by toning, is replenished by a stock solution, which may be made as follows:

Terchloride of gold..... 15 grains
Water to..... 2 ounces

Each dram contains about one grain gold chloride, and a sheet of paper 17x22 inches will absorb about one grain of gold. We take for granted that the reader will buy his "gold" in the hermetically-sealed glass tubes on the market. It is never pure, and seldom up to announced strength, but answers the purpose when used as above.

2. Sodic biborate ("borax")..... 60 grains
   Hot water..... 10 ounces
   Gold terchloride..... 1 grain

Gives good, warm tones, but must be used at once, as it will not keep. It is, above all, important to keep toning solutions *alkaline*, distinctly, but not violently, so, and ammonia will be found as suituable as any alkali for the purpose.

If the prints tone very rapidly to a blue color, the gold is, probably, in too great quantity; the prints will lose their tone in the fixer, and the result will be fugitive. If the prints tone unevenly, the cause is either acidity, too much gold, or too high temperature. If patches refuse to tone, probably they have been touched with greasy fingers. The toning should take at least ten minutes, we prefer it to take fifteen or twenty. The prints must be kept in constant motion, and on no account be allowed to stick together, or to the side of the dish. The prints should be removed from the toner when by transmitted light they appear about the color finally desired; by reflected light there will be a trace of blue beginning to appear on the high lights. Practice alone can teach to what degree prints

FIG. 23.

should be toned; some workers tone by dull, diffused daylight, others prefer artificial light. So long as the same kind of light is used, and the color carefully noted, it is immaterial what light is used. After toning is finished, the prints are placed in clean water, but unless a little common salt is put into this water, toning is apt to continue.

Fixing is done in a solution of sodic hyposulphite one part, to water five or six parts, and the solution *must* be alkaline, and should be about 60 deg. Fahr., certainly not cooler. The prints should be moved about in the fixing solution as in the toning, and fifteen minutes at least should be allowed for the

fixing. After fixing, the hypo must be thoroughly eliminated by washing. This is not so easily effected as might be imagined, for hypo sticks with great tenacity to textiles such as paper.

A great many washing machines are on the market, some good, others useless. It is important to remove the hypo as rapidly as possible, for prolonged soaking in water injures the prints. We advocate manual washing contrivances, so far as such can be carried out. If the print is laid face downward on a sheet of glass, a rose tap playing on the back, and a squeegee passed repeatedly over the back of the paper five or six times during two minutes, more hypo will be removed than by three or four hours of washing in any of the washing machines we know. Hot water removes a great proportion of hypo, but if too hot, it will alter the tone of the print. If a washing machine is to be used, it should be on the "exit-from-the-bottom" principle, as the hypo-contaminated water sinks; the prints must be kept in constant motion, and a false bottom, on which the prints may drip at intervals is an advantage. The

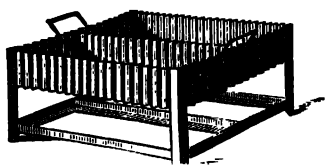

FIG. 23*a*.

old circular porcelain washing-dish answers our description as well as any; we use ourselves a large wash-tub arranged on the same principle. The change of water should be constant, and its current circular, so as to cause the prints to keep traveling around the machine. If running water cannot be used, frequent changes, with intermediate spongings, must be used in default. Our figure 23 shows a very good washing machine, and 23*a* shows a rack for holding glass plates in the same machine.

A sufficiently accurate test for hypo remaining in a print is starch iodide, prepared by adding to "tincture of iodine" a little starch dissolved in boiling water. This will give a dark blue liquid, to which water is added till the color is *very* pale

blue. Touch the back of the print with blue solution; if hypo is present the blue will be dispelled; if there is no trace of hypo, the color will remain. If a print is *mashed up* in water, and the above test made with the water, the test will be more conclusive.

The washing being finished, the prints are dried between sheets of pure blotting-paper, or in any convenient way. Before they are quite dry they should be rolled, albumen side outward, round a cylinder of wood or cardboard, and kept so till quite dry, they will then leave the cylinder with a fine surface-gloss.

Blisters, large or small, sometimes appear on prints in the first water after fixing. Small blisters presenting a pretty hard surface usually disappear and do not finally damage the print. The large, soft blisters always spoil prints, and, once they appear, seem to be incurable. To avoid both kinds: Let the first water after fixing be tepid. Add a little common salt to the first water after fixing. Add a little alcohol or ammonia liquor (ten drops to each half-pint of fixer) to the hypo solution. If these fail to prevent blisters, which appear on double albumenized paper, but not, within our experience, on ordinary albumen paper, wait for a change of weather; failing all these, reject the sample of paper.

Prints Yellow, where they ought to be white, are produced by keeping the paper too long after sensitized before printing, or after printing before toning.

Metallic Spots are due to impurities, probably iron, in the paper, or in the blotting-paper used at some stage.

Bronzed Shadows and *Violent Contrasts*, if the negatives are not at fault, point to over-strong sensitizing bath.

Want of Contrast, if not due to the negative, is due to a weak sensitizing bath.

The *Mounting* of prints hardly comes within our scope; we shall confine ourselves to saying that the mounts must be above suspicion of matter deleterious to the prints, and the mountant or adhesive substance used must be neither hygroscopic nor liable to turn acid. India-rubber solutions lose their adhesiveness after a time; *fresh* starch solution, and gelatine dissolved

with an antiseptic such as thymol is often used. Good glue seems a favorite mountant with professional mounters. Mr. Alex. Cowan's ingenious method of mounting dry is well worthy of notice. Mr. Cowan applies starch to the back of the prints when damp, and thereafter allows them to dry. He damps the mount and not the print—which obviates the distortion due to stretching produced by wetting the print—and he lays and arranges the dry print on the dampened mount, then passing the whole through a rolling-press.

To Enamel Prints.—Coat a clean and talced glass plate (see page 106) with plain collodion; wash when set; lay the plate face up in a hot solution of: Gelatine (white), one ounce, water, ten ounces. Immerse the print face down in the same solution for a moment, then bring plate and print in contact out of the solution; squeegee the back of the print, using a rubber cloth between print and squeegee. Avoid air-bells; allow to dry. Cut round edges and strip. A very high gloss will be found on the print, if it was quite dry before stripping.

If it is desired to mount the print, this must be done before stripping, by placing a sheet of thin cardboard at the back of the print while it is on the glass plate, and still damp with gelatine solution. The cardboard itself may be laid for a moment on the gelatine solution before being placed in contact with the print, and to prevent the cardboard springing away from the print, a flat board may be laid on the top of the card and a weight placed on the board.

To Mount a Print in "Optical Contact" with Glass.—The glass should be free from scratches and as clear as possible. It is not talced nor collodionized, but the print is fastened to it with gelatine solution as for the enameling process.

After prints on albumen paper (not enameled) are mounted, they are usually passed through a hot "roller" or "burnisher," in order that they may have a certain amount of gloss.

The process of rolling calls for no remarks.

CHAPTER XXII.

PREPARATION OF NEGATIVES FOR PRINTING, COMBINATION PRINTING, VIGNETTING.

(Though many of the remarks in this chapter apply to all printing processes, we insert them in this place chiefly on the score of convenience to our readers and ourselves).

It must not be taken as a matter of course that the washed and dried negative is there and then ready for the printing frame. In some cases it may not be capable of improvement, but in many cases some manipulation is necessary, and in most cases the negative may be greatly improved by manipulation. Leaving alone the vexed question of "retouching," we may at least point out the immense value of manipulating *masses* on the negative. Weak foregrounds may be strengthened, glaring distances may be toned down, balances of light may be introduced, and to the artistic eye many improvements may suggest themselves which may be carried out by a little simple manipulation, and against which there is assuredly neither law nor reason. For such purposes as these, besides the processes of intensification and reduction, general or local, already mentioned, we may suggest a few dodges that may be used for making the best of negatives not quite perfect when completed by the processes already described.

To strengthen either locally or generally a finished negative, a film of a material more or less non-actinic may be used. For such a purpose the plate may be covered on the back with a coat of collodion or varnish containing a yellow dye, as *aurantia;* the whole of the back is first coated in the usual way, and from the parts, if any, that are dense enough the film is scratched away. "Mat varnish" may be used in the same way, with the additional advantage that this medium

takes very freely any ground pigment, as plumbago applied with a soft "stump," or even with the finger, or a pad of wool or cloth. A formula for mat varnish is to be found among our formulæ at the end, but it may be bought ready made at any dealers. A backing of any translucent or yellow-colored medium undoubtedly causes the negative to yield, with any contact printing process, a print more brilliant than without the backing would be obtained; but, perhaps, the amount of advantage gained by this proceeding has by many been overrated.

Printing in a strong light certainly yields prints of less vigor than printing in a subdued light; hence an over-dense or "hard" negative should be printed in sunlight rather than in diffused light, and near a strong light rather than a weak one in printing processes where artificial light is used. (There are, however, exceptions to the latter part of the last sentence.) A very thin, weak negative printed in diffused light, or under ground-glass or tissue-paper or yellow glass, will undoubtedly yield a "pluckier" print than the same negative printed in the straightforward way.

What is called "double" or "combination" printing is in some hands carried to a point of great excellence; we do not propose to deal with it except in one phase—that of printing clouds from a separate negative over a view already printed from an ordinary landscape or architectural negative. A plain, white piece of paper intended to represent the beautiful canopy that stretches over our heads in nature, is an insult to artistic ideas seldom perpetrated nowadays. But incongruous, inappropriate or impossible clouds over a landscape is an insult still more gross than the white paper, and such carelessness as printing clouds on the top of architecture, trees or hills is unpardonable.

To make a cloud negative no special process is required. A slow plate and a rapid exposure coupled with a fairly restrained developer will insure a good cloud negative. The negative should not be made by any means dense, unnecessary density simply entails more trouble in printing. Of course, clouds must be chosen of a nature and in an aspect likely to be

useful for the purpose for which they are intended. Very stormy clouds can very seldom be used, simply because landscapes are very seldom photographed in very stormy weather. Clouds with the sun right in the middle, whether the sun is seen or only suggested, will be of use only for landscapes taken with the sun right in the front of the lens, which is a matter of rare occurrence. Clouds such as found right overhead in the zenith are not likely to be appropriate for printing close to the horizon, any more than clouds characteristic of the ocean are likely to be suitable for inland scenery. Still more emphatically, clouds lighted from the left are not adapted for printing over a landscape lighted from the right, though we have seen a "gold medal" attached to a picture so composed.

Clouds are best photographed on the level, if possible; the less the eminence from which they are taken the better as a rule. But sometimes there is no choice.

If the original sky of the view negative print any degree beyond a pale gray, the sky will require to be "blocked out" with opaque paint of some kind. A pale gray horizon over a landscape is better than a hard, chalky white for our purpose, but anything darker than pale gray will require blocking out. If the gray is a shade darker than it ought to be, a cloud negative presenting considerable contrast may be chosen, provided it is otherwise suitable. As a rule, a very chalky sky means an under-exposed negative.

The blocking out may be done on the face of the negative with a solution as thick as possible of vermillion water-color paint or India ink.

Opaque material is, we believe, sold for this and similar purposes. So long as the landscape horizon presents a sharp line there is no difficulty for a steady hand, but if tree-branches project into the sky the operation becomes more difficult. Branches are best blocked out not by straight lines, but by "dabs" or stippling on the back of the negative. Practice alone will teach this. Very intricate architectural lines are often puzzling, but care and practice will enable us to block them out perfectly.

In our last chapter we showed the usual manipulation of printing by contact, and the reader must have a certain amount of practice in ordinary printing before he attempts, or is likely to wish to attempt, combination printing.

The landscape being printed by a printing-out process, and visible, as in the albumen paper process, or partially visible, as in the platinotype process, a suitable cloud negative is selected and placed face to face in a suitable position with the landscape print, which has the sky white, or nearly so. The two are then laid in a printing frame together, the cloud negative undermost, the frame is then closed in the usual way. If the cloud negative be not too dense, or the landscape sky not too dark, the shape of the cloud will be distinctly seen from the front of the frame, and the horizon line of the landscape will be easily recognized. The frame is laid face up in the usual way for printing, and the landscape is entirely covered with a *limp* opaque cloth, as velvet. When the horizon of the landscape is a sharp line, as of hills, the difficulty is slight; where the outline is jagged, the operation requires more skill. To avoid a hard line the upper edge of the velvet must be constantly moved if the printing is done in sunlight, frequently if in diffused light. The cloud picture is to be graduated or "vignetted" down to the landscape. Where there is a dark mass already printed against the sky, as in the case of heavy foliage, the mass may be practically disregarded, as that part, being already dark, any clouds in the negative coming over it cannot naturally be printed, the paper being already printed in these parts. Thus, where dark tree-branches come against the sky, the cloud may, in many cases, be printed right over and branches; if this is well done, the result is very natural the satisfactory.

"*Vignetting*," or graduating the margins of the picture instead of printing the subject dark to the edge, is performed in various ways. Glasses are sold with their centre white, and graduated in an oval or pear shape to a red edge. When these are well made they give a very good vignette. The usual way, however, is to cut out of a piece of cardboard, sheet lead, zinc, wood, or other opaque material, an opening of the desired

shape and approximately the desired dimensions. The inner edges of the "masks" are serrated and the printing is done with the mask an inch or two in front of the negative. A piece of tissue-paper is usually placed over the aperture in the mask to insure better gradation. Vignette printing is done in diffused light, and the further the mark is away from the negative the softer the gradation. The "vignette" is a style highly popular for portraiture, and is well suited to many landscapes, though much less used for that class of subject.

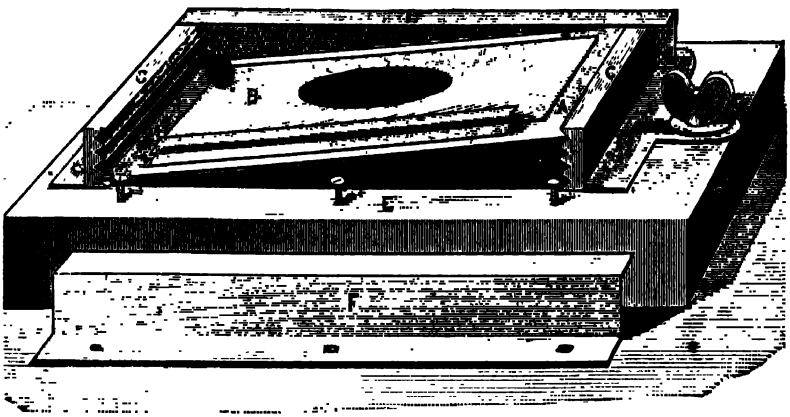

FIG. 24.

We figure an arrangement that will enable one to produce and to vary vignettes almost at will, and with a very little practice.

CHATER XXIII.

PRINTING OF PLAIN SALTED PAPER.

This is an old process, which has, unfortunately, gone somewhat out of use of late years; but none the less beautiful results can be got with it, and though it seems difficult to get a certain class of tone—engraving black, or very dark blue—still if the process were worked by many persons, there would be a chance of some one lighting on a system by which perfect tones of the desired kind could be obtained. As it is, very beautiful tones can be got, and we hope to see the process receive more attention in the future than in late years.

The paper used for albumenizing is eminently suited for this process, but any good wove paper will answer the purpose. It must be sized and salted. A formula found in "Hardwich's Photographic Chemistry," 5th edition, page 311, will suit all purposes. The paper (Saxe) is floated upon the following solution:

Ammonium chloride	60 grains
Gelatine	20 grains
Water	20 ounces

Dissolved by heat and filtered when cold.

Mr. Otto Schólzig, of London, favors us with a "size," which will be found splendid for an ordinary silver nitrate sensitizing bath. The ammonia-nitrate bath, which is recommended later, may dissolve the albumen, though in our hands it did not do so.

Sodic chloride	250 parts
Citric acid	10 parts
Irish moss	50 parts
Gelatine	20 parts
Albumen	500 parts
Water	2000 parts

The paper having been floated, face downward, on one of the above sizing and salting baths, is hung up to dry. The *back* of the paper may be recognized by the faint "crapy" marks due to the gauze on which the paper is laid to dry after its manufacture.

The sixty grain bath of silver nitrate as given for albumen paper will answer equally well for this paper.

Paper sized by our first formula (Hardwich's) may be sensitized on an ammonia-nitrate bath. A sixty grain solution of silver nitrate is taken and "converted" as described on page 61. Other operations are the same as for albumenized paper. After the plain silver nitrate bath, the paper may be floated, when only surface dry, face upward, on a bath of citric acid five parts, water one hundred parts. This will preserve it for a long time.

With plain paper the printing has to be considerably deeper than with albumen paper. Washing is conducted on the same principles; the ammonia-nitrate paper will probably require salt in the washing water.

Any good toning solution will answer for plain paper, but to get fine tones, as nearly as possible approaching black, the following toning bath is recommended.

Sodic tungstate	20 grains
Sodic phosphate	20 grains
Boiling water	3 ounces

Dissolve and add

Gold terchloride	1 grain

Allow to cool, then add

Water	5 ounces

The toning and fixing bath given as a toner for gelatine chloride paper, in next chapter, will also answer admirably for plain salted paper.

CHAPTER XXIV.

GELATINE-CHLORIDE PAPER FOR PRINTING-OUT.

Paper coated with an emulsion of silver chloride in gelatine, in the presence of a certain proportion of an organic silver salt, has found its way on to the English market. This class of paper will be found highly suitable for certain negatives and certain effects. Though the papers have reached us under two names, the preparation and qualities seem to be practically the same, certainly the same treatment answers both samples. Very thin negatives will be found to give better results on these gelatine chloride papers than on albumen or plain salted paper; and with very little trouble a very high gloss can be given to the finished prints. When so glazed the paper renders shadow detail in a remarkably perfect manner.

The printing is done by contact in the usual way, printing being, if anything, rather more rapid than with albumen paper.

The toning bath recommended for Dr. Liesegang's gelatine-chloride paper is his own.

Water	24 ounces
Sodic hyposulphite	6 ounces
Ammonium sulpho-cyanide	1 ounce
Saturated solution of potash alum	2 ounces

Dissolve, place in this solution some scraps of gelatine-chloride paper for twenty-four hours. Filter, and add:

Water	6 ounces
Gold terchloride	15 grains
Ammonium chloride	30 grains

This bath tones and fixes at the same time. No washing is required previous to immersion in this bath, nor fixing after it. The color during progress of toning must be judged by transmitted light; reflected light is here no criterion.

Herr Obernetter's paper will probably be found to work better with the following toning bath, followed by the usual fixation in hypo :

Ammonium sulpho-cyanide	140 grains
Sodic phosphate	140 grains
Sodic tungstate	100 grains
Water	24 ounces

Dissolve, place in the solution scraps of the paper as before, filter and then add:

Gold terchloride	15 grains
Water	4 ounces

Examine during toning by transmitted light (*i.e.*, by looking *through* the print) and tone to a fine rich brown or a purple blue, as desired. A solution of hypo one part, in water ten parts, is strong enough for fixing. After fixing and washing, the prints may be allowed to dry hanging up (*not* between sheets of blotting paper), in which case they will have a good medium surface; or they may be squeegeed to talced glass and stripped when dry, when they will have a very high gloss.

CHAPTER XXV.

CONTACT PRINTING ON GELATINE-BROMIDE PAPER.

This fine process has, during the last few years, thanks in a great measure to the perfection to which it has been brought by certain firms, gained a firm hold on public esteem. Certain marked and undeniable qualities in the product turn the balance strongly in favor of this process, as compared with all other processes where silver salts are used. There is no free silver nitrate to form suspicious or objectionable compounds with organic substances; gelatine is safer in the matter of sulphur compounds than albumen, even were free silver nitrate present to combine with the gelatine. The rapidity with which a single print, or a "long number" of prints may be produced, is far beyond that of most other processes. The latitude in quality of negatives is far greater with this process than any other, a good print may be made from a negative practically unprintable by any other process; lastly, the results are in artistic quality inferior to no process of pure photographic printing at present known. The chief disadvantage of the process is—and it is a serious one—that the image is invisible until developed, so that no combination printing can be effected without rather intricate and, at the best, uncertain operations and apparatus. It may also be put down as a failing that the progress of printing is invisible and that some experience is required before even decent results are obtained, but those who have had a little practice will probably spoil as few sheets of paper by this process as by any other.

A *good* sample of bromide paper is coated with a very thin layer of fairly rapid emulsion, containing a large proportion of the silver haloid. The thin layer is necessary to prevent

the paper from curling in aqueous solutions, and the large proportion of silver is needed to give pluck to the very thin film. On account of the thinness of the film, and in spite of the large quantity of silver in the film, it will be found that there is but little "latitude" in exposure; and timing must be pretty nearly correct for our developer, or we shall fail to produce a satisfactory result. But a little practice and care will enable the worker to judge almost by intuition the exposure necessary for any particular negative, provided that the light used be always the same in actinic quality and visual intensity. On account of this important *proviso* artificial light is to be strongly recommended, if not insisted upon. It does not much matter what the radiant is, provided the light be constant and equal at all times. An oil lamp, always turned up to the same point, or a "regulating" gas burner will be found most suitable. Another point, which, if disregarded will introduce even more uncertainty and risk of failure than the light, is the *distance* from the light to the negative. Here the oft-quoted law comes in, that the intensity of light varies inversely as the *square* of the distance from the radiant to the recipient. If the correct exposure at two feet be twenty seconds, at eight feet it will be three hundred and twenty seconds, not eighty seconds, as some may suppose. Or if the correct exposure at two feet be twenty seconds, and if, by mistake, we expose at three feet instead of two feet, we shall under expose just two and a half times, as $2^2 : 3^2 :: 20 : 45$, forty-five seconds being the exposure required at three feet to correspond with twenty seconds at two feet.

Regarding exposure, a few general rules may be useful, but it must be remembered that they *are* general, and have exceptions:

The denser the negative the more the exposure required, and *vice versa*. Practically this has no exception.

Long exposure leads to softness, harmony, flatness.

Short exposure tends to brilliance, pluck, hardness.

Strong development gives pluck, contrast, hardness.

Weak development gives harmony, softness, effeminacy.

Strong restrainers lead to pluck, brilliance, hardness, bad color and want of detail.

These rules do not cover all circumstances; for instance, a long exposure coupled with a too strong developer would give flatness or fog in place of brilliance; but, given two prints of the same negative equally and normally exposed, a strong developer will yield a pluckier image than a weaker developer.

The standard or stock solutions for ferrous oxalate developer, are saturated solutions of ferrous sulphate and potassic oxalate as given on page 91. As a rule the iron solution should bear a less proportion to the potassic oxalate solution for bromide prints than for development of negatives. And a small proportion of soluble bromide is to be recomended for development of bromide prints. A *strong* normal solution may be prepared thus:

A. Potassic oxalate saturated solution..... 4 ounces
Potassic bromide, 10 per cent. solution.....25 minims
Iron sulphate, saturated solution..... 1 ounce

A *weak* normal solution:

B. Potassic oxalate, as above..... .. .. 6 ounces
Potassic bromide, as above ....25 minims
Iron sulphate, as above..... ..... 1 ounce

A *very weak* solution:

C. *B* solution..... .... 2 ounces
Water..... 2 ounces

We are now in a position to put into practice the principles laid down in the last page or two. If we have an average density negative we may make from it a plucky, brilliant print by infra-normal exposure and sharp development; or we may give our print a soft, harmonious character, by full exposure and a developer such as *B*. A "ghostly" negative, such as would be unprintable by any other process, may be exposed behind a sheet of ground or opal glass, the exposure being kept down and developer *A* being used, a little extra bromide being added if required. A "chalk and soot" negative will be best treated by very prolonged exposure followed by a weak developer as *B*, or in aggravated cases, by a watery developer as *C*.

When the exposure has been too short, a trace of sodic hyposulphite may be added to the ferrous oxalate developer; but it must be only a trace, and at the best it is a dangerous

experiment, and one we do not recommend. It will be found better to make a fresh exposure, putting the spoiled sheet of paper among the residues.

After development, which must not be carried too far, the paper should be washed in acidulated water, not in plain water, least of all in ordinary tap water containing lime. Half an ounce of acetic or citric acid added to a quart of water will be found sufficient; the quantity does not matter so long as the reaction is acid and the acidity not strong enough to damage the gelatine. After two or three rinsings in acidulated water, which enables the iron to be washed out, the print is washed in plain water so that acidity may not be communicated to the fixing bath, which is the usual solution of sodic hyposulphite alkalized and requiring no special remark.

The ferrous oxalate developing solution may be used repeatedly while fresh; by certain workers a previously used solution is stated to give the best results. We have not been able to verify this statement, and this practice introduces an element of uncertainty which, for beginners, might prove puzzling.

The hydrochinon developer has, in our hands, with Eastman's bromide paper, given the very finest results, and we recommend this developer especially for beginners; provided the exposure has been sufficient and not outrageously overdone, the action of the developer is so even that nothing but attention is required to stop development at the proper stage in order to obtain grand results. The formula given is practically that given by Mr. B. J. Edwards for lantern-slide plates.

Mix in the following order:

Sodic sulphite	2 ounces
Water	20 ounces
Hydrochinon	30 grains
Sodic carbonate, "pure," but not "dried"	3 ounces
Potassic carbonate	3 ounces
Potassic bromide	40 grains

There may be a difficulty in causing solution of all these in the water unless the water is hot. The water may be divided

into two quantities, the sodic sulphite, hydrochinon, and bromide being dissolved in one part, the other salts in the other part of the water. The solutions in this state will keep a long time and may be mixed in equal parts for use. But the hydrochinon must be reasonably fresh when dissolved, as it does not keep very long. When over-kept it acquires an unhealthy brown appearance in the dry state.

Sepia or brownish tones may be obtained by alkaline pyro development, though no very great measure of success has as yet attended this system. The following will be found fairly suitable:

Pyrogallol	1 to 2 grains
Water, with a trace of citric acid	1 ounce
Ammonia	2 minims
Bromide	3 grains

The prints must remain in the fixing-bath of hypo one part, water five parts, alkalized, for about fifteen minutes, and on being put into this bath, they must be immersed at once, and not unevenly acted upon by the hypo. The time allowed for fixation *must* be ample, and the solution *must* be alkaline, otherwise the claim for permanence of result will surely be falsified.

The manipulations of development call for few remarks; the prints should be soaked in clean water, air-bells being removed before development. This is simply to make them lie flat in the developing dish, which should be flat, and, preferably, white. In all cases where the ferrous oxalate developer is used, the iron solution is to be poured into the oxalate. If it is desired to keep the mixed solution, the bottle figured and described on page may 92 be used.

Washing and Drying Bromide Prints.—The same principles as we stated for washing albumen prints hold good here. Washing machines may be used, but are inferior to manual labor, and the use of the rose-tap and squeegee. (See page 130.) If any trace of discoloration of the high lights be observed after fixing and washing, the prints may be immersed in a saturated solution of alum with a little hydrochloric acid. After this they must again be carefully washed. If blisters

occur after fixing, a little common salt added to the first washing-water will prevent a recurrence.

Bromide papers are sold usually in three qualities: No. 1, a fine paper with a smooth-surfaced film; No. 2, a heavier paper with a smooth surface; No. 3, a heavy paper with a rough surface. Prints on No. 3 should be allowed to dry spontaneously; those on Nos. 1 and 2, if dried spontaneously will have a very good smooth surface, but if squeegeed to talced glass or polished ebonite, and stripped when dry, will have a high gloss. To produce a very high glaze, a talced plate may be collodionized and washed, and used as given elsewhere.

Mr. H. Senier, of London, England, has produced warm tones in bromide prints by developing the prints after exposure in the usual way with ferrous oxalate, then bleaching the image out with chlorine water and re-developing in daylight with ferrous oxalate.

Bromide prints may be mounted by appplying to the back while they are drying on their ebonite or glass support sheets of thin cardboard, the mountant being starch, to which Messrs. Fry & Co., of Richmond, recommend the addition of a small quantity of lump sugar.

Opal plates bearing gelatine-bromide emulsion for this purpose may be treated in the same way as paper.

The last outcome of Eastman ingenuity is a process called "Transferotype." This is simply a stripping film of gelatine-bromide emulsion suitable for printing. The film of emulsion is said to be not over one five-thousandth of an inch thick. The prints are developed in the usual way. After washing they are squeegeed to opal plates prepared to retain the film permanently; the paper is removed by hot water, and the result is an opal positive of a quality that only requires to be seen in order to be appreciated. In this process two things are to be guarded against—over-exposure and over-development. (See remarks on Transferotype for Lantern-Slides, page 18[illegible])

CHAPTER XXVI.

RAPID PRINTING PAPER.

About 1884 or 1885, a printing process was introduced, which came to be called the "rapid printing process," because it was more rapid than the printing-out processes commonly used at that time. The paper is coated with very slow gelatine bromide, or chloride, or chloro-bromide emulsion. The exposure is very long compared with other silver printing processes by development, and development produces a red image amenable to toning.

A bright yellow light may be used in the operating room, and exposure may be one or two seconds to daylight, or several minutes to artificial light. As a rule, the printed instructions mislead the worker into giving too short exposures.

The developer may be ferrous oxalate, very weak, and containing chloride, and sometimes a citrate. The following will serve as an example.

a.	Potassic oxalate	2 ounces
	Ammonic chloride	40 grains
	Water	20 ounces
b.	Ferrous sulphate	4 drams
	Citric acid	2 drams
	Water	20 ounces
c.	Ammonic bromide	1 ounce
	Water to	4 ounces

Developer.

a	1 ounce
b	1 ounce
c	2 drams

Before development soak in water till the prints lie flat, and care must be taken not to over-develop. To prevent develop-

ment going on after the prints are removed from the developer, they are put into water containing a good dose of common salt. A black tone after development proves insufficient exposure, and will, of course, prevent toning. After several changes of water, the prints are put into a concentrated solution of potash alum, and again washed, after which they are toned in

Sodic acetate	30 grains
Lime chloride (fresh)	3 grains
Gold terchloride	1 grain
Water	5 ounces

After toning, the prints being washed, are fixed in a one to ten alkaline hypo solution.

The prints may be, as suggested by Mons. Warnerke, toned and fixed in one bath. To do this, make the fixing-bath one to three, and add to every five ounces, one grain gold terchloride.

The prints may be dried, squeegeed to talced glass, or allowed to dry in the ordinary way.

CHAPTER XXVII.

PLATINOTYPE OR PRINTING IN PLATINUM.

THIS process is one daily gaining ground in public favor, and not without reason, for not only are the results of a beautiful and artistic character, but the process carries with it a prospect of permanence almost beyond the scope of reasonable doubt. This must not be taken to mean that a platinotype print is indestructible as to the image any more than as to the paper; but it may safely be asserted, and by one of the writers it has been tolerably clearly proved, that only tests utterly unlikely to occur in the ordinary treatment of any print will spoil or even affect a properly prepared platinotype print. The prints have a character in the shadows not vouchsafed to other processes of photographic printing, and the manipulations though requiring care in certain respects are perfectly simple. The chief disadvantage of the process, if it is a disadvantage, is that the negatives to be printed require to be of something rather better than average quality, a long range of gradation being almost a *conditio sine qua non* for a good print.

The image is composed of platinum presumably in the metallic state. The process was invented by Mr. W. Willis, Jr., of London, and is protected by letters patent in England and in America; a license is granted on nominal terms for working the process, and the materials requisite are supplied by the Platinotype Company. Indeed, it is little probable that anyone not an experienced chemist would be able to produce the chemicals himself, and even the paper has to be prepared in a special manner. The most complete work on the subject is by Pizzighelli and Hübl. ("Platinotype," by C[illegible]. Pizzighelli and Baron A. Hübl, translated by the late J. F.

Iselin, M.A., and edited by Capt. W. de W. Abney, R.E., F.R.S. London: Harrison & Son, 59 Pall Mall.)

Organic ferric salts are by light reduced to the ferrous state, and these ferrous salts in solution reduce to the metallic state certain metallic salts, notably those of platinum. Paper treated with ferric oxalate and potassic chloro-platinite is exposed dry to light. The ferric oxalate becomes ferrous oxalate, which is soluble in potassic oxalate in solution. The exposed paper being treated with a solution of potassic oxalate the ferrous oxalate is dissolved, the potassic chloro-platinite is reduced, and metallic platinum is deposited in very fine division, its color in that state being black. The amount of platinum reduced is proportionate to the amount of light-action.

Evidently this is a development process; it is also to a certain extent a printing-out process, for the printed image is partially visible before development, and, as shown later, the process may be worked as one entirely of printing-out. The following important consideration should noticed. In a print-out process the reduction to the metallic, or at least to the visible state, takes place absolutely *in situ;* as the light action proceeds the deposit is piled up in the shadows; in a development process such as we are describing, the salt is being dissolved as the metal is being deposited, so that we may look for less "blocking up" in the shadows where the reduction is most energetic. We are informed on the best authority that a platinum printing-out process was worked as early as 1873, but rejected on account of this very blocking up of the shadows.

The Practice of the Process.—The paper for platinotype printing may be bought ready-sensitized, in which state under conditions to be stated presently, it will keep good for a long time—for a month, at least. The necessary conditions for keeping the paper are: Protection from actinic light and protection from *damp*. The prepared paper is in a high degree hygroscopic, and the slightest excess of damp to the paper will ruin it. To preserve the paper from both light and damp, a "calcium tube" is used. This is a cylinder of metal, capped

at each end, and in one of the caps or lids is a perforated chamber containing calcic chloride, which attracts to itself all moisture, and so keeps the paper dry. Usually asbestos is impregnated with the calcic chloride, and when after a time the asbestos becomes a damp mass, it is put on an iron shovel or plate over a fire and the damp driven off by heat.

The Company also sell the paper and the sensitizing materials separately, and this is useful for those who work the process on a very large scale or only on rare occasions. Moreover, by varying the proportions of sensitizing ingredients, better results may be got from negatives of varying qualities.

The platinum salt is sold in the solid form, the iron as two separate solutions, which are to be mixed in various proportions. We do not know the precise constitution of these two solutions, which are simply marked "A" and "B," so we can only quote from the Company's printed instructions. By increasing the proportion of "A" to "B," half tone is lessened, so that a large proportion of "A" is suitable for weak, thin negatives. *Vice versa*, increasing the proportion of "B," gives a solution more suitable for hard negatives. An average mixture may be:

A	1 part
B	5 parts

Of such a mixture 1 ounce may be used to dissolve 60 grains of the dry "platinum salt," but this complete sensitizing mixture will not keep above half an hour, and in hot weather not above ten minutes. On no account must heat be applied to effect solution, stirring with a glass rod being sufficient to cause solution of the platinum salt. The paper is pinned to a flat board, and the sensitizing solution quickly spread over the paper with a perfectly clean sponge or pad of flannel. For each square foot of paper about 80 minims of sensitizing solution will be required. The solution is poured right on the middle of the paper, and immediately spread over the whole surface. It may be necessary to work in dull daylight, as by yellow light it is difficult to see to spread the yellow solution properly, but each sheet when coated must be at once removed to non-actinic light, and the sponge or pad must be frequently

washed. Platinotype paper is, in the first place, much more sensitive to light than albumen paper (as two or three to one), and in the next place, light hurts platinotype paper more than albumen paper, for any slight veil contracted by the latter before toning is removed by the toning and fixing-baths, which is not the case with platinotype paper, with which there is no analogous "clearing" action. Platinotype paper should be dried in a room with a stove or open fire, and the room must be lighted non-actinically, if at all; the drying should be arranged so as to take about ten minutes. When apparently dry, the paper should be held near the fire for a minute to drive off all trace of moisture. It is then placed in a calcium tube and kept absolutely dry. Damp is probably by far the most frequent cause of failure with this process.

Printing is performed by daylight and contact, and special precautions should be taken against damp. The frame pads should be well dried, and a sheet of India rubber should not only cover, but overlap the platinotype paper in the frame. The printed image is of a peculiar yellow orange color, with a tinge of green in the deepest shadows. When the printing of an average negative is finished, the very highest lights are not visible, and the shadows present a color not easily described. Practice is the best, and, indeed, the only guide to correct judgment of printing. The print should not be *too* frequently examined, on account of the danger of both light-effect and damp. When the printing is finished the paper is placed in a calcium tube as before.

Development.—Make a saturated aqueous solution at 60 deg. Fahr. of potassic oxalate, rendered distinctly acid with oxalic acid. (The Company, it appears, now recommend a faintly alkaline solution.) Heat the solution to about 140 deg. Fahr., more or less, according to considerations to be pointed out presently. An enameled iron flat dish is the article generally used to contain the solution, and a Bunsen or other burner is placed below it to keep the solution up to temperature during the process. The prints are immersed in the solution for five or six seconds, or they may be pulled slowly through the solution; the image starts up in black suddenly. Air bells should

be avoided, but if they occur the sheet must be replaced for a moment or two in the solution, and, as a rule, no harm will be found to result from the air bells if this be done.

The temperature of the bath is regulated chiefly by the amount of printing. An over-printed proof may be developed in a cooler solution, as 120 deg. Fahr. An under-printed proof will be saved by a higher temperature, as 180 deg. Fahr. But the best results are got by arranging the printing so that development will be performed at about 140 deg. Fahr.

After development the prints *must not* be placed in plain water, but in:

Water	60 parts
Hydrochloric acid	1 part

If, on immersion of the prints, this solution becomes milky, the acid is too weak. After a few minutes in this the prints are removed to a second bath of the same constituents, and after a few more minutes into a third. The last bath should not show the slightest tinge of yellow. After the third bath the prints are to be washed for about ten minutes in running water, when they will be ready for drying and mounting.

Sepiatones on platinum prints. The Company sell paper specially prepared, and a developing solution also prepared by special methods, the nature of which is not published, for producing a sepia tint. Borlinetto claims to produce a sepia tone by using a *cold* developer:

Saturated solution, potassic oxalate, as above	40 ounces
Oxalic acid	200 grains
Saturated solution of cupric chloride, as above	4 ounces

The prints may remain some time in this solution, as long as twenty minutes if necessary.

Pizzighelli's latest platinotype experiments. This able worker goes upon two leading principles: 1st. To prevent the sensitive substance from sinking into the paper; this he does by using a "vehicle" such as gum arabic or arrowroot. 2d. To combine with the sensitizer, from the very first, a developing solution. This he does by adding to the original potassic chloro-platinite a quantity of neutral ammonia-ferric oxalate or

sodium-ferric oxalate. The processes for preparing these ferric oxalate solutions are too intricate for us to follow here.

With paper prepared in this manner we have several alternatives. The picture may be printed right out. It may be printed nearly out, and the print left in the dark to complete the printing, for "the reduction of platinous chloride, once introduced, is continuous in the dark." Or the partly printed out image may be developed by

Saturated solution of sodic carbonate.....	5 parts
Distilled water	100 parts

Lastly, the paper may be used exactly as ordinary platinotype paper. In all cases the "clearing" is performed as given above.

Any negative which will give a thoroughly good print on albumen paper will give a good platinotype print. The qualities essential to the negative for this process are fair density, and *long scale of gradation* from high-light to shadow. The dried prints do not "cockle," and the mounting needs no special notice.

CHAPTER XXVIII.

THE CARBON PROCESS, OR PIGMENT PRINTING.

If gelatine is exposed to light in presence of certain chromates, the chromate is reduced, chromic acid liberated, and the gelatine thereby rendered insoluble. If a finely-ground pigment be incorporated with the gelatine, the pigment will remain in the insoluble gelatine when the soluble is washed away, and an image consisting of pigmented gelatine will be the result. These are the fundamental principles of the carbon printing process.

Carbon tissue, as prepared for this process, consists of paper coated with gelatine, containing in intimate mixture certain pigments, and containing also a certain proportion of some such substance as sugar, to prevent the dried tissue from being too hard and brittle. The tissue is sometimes sent out sensitized, but it is better for the worker to sensitize it himself, unless he proposes to use his sensitized stock at once. The unsensitized tissue will keep indefinitely.

The tissue is sensitized in a solution of potassic bichromate, rendered alkaline with ammonia. The alkali increases the keeping qualities of the tissue, but perhaps makes the printing slower. A normal bath may be:

Potassic bichromate	1 ounce
Water	20 ounces
Ammonia, at least	1 dram

but not more than will change the reddish color of the bichromate solution to yellow.

In very hot weather and for very thin negatives the proportion of water may be greatly increased (say to 50 ounces for 1 ounce of bichromate), and for very hard negatives the solution may be more concentrated (as 7 ounces of water to 1 ounce

bichromate.) In very hot weather as much as 30 per cent. of the water may be replaced by alcohol.

Apparatus required for sensitizing: A flat dish of porcelain, glass, zinc or papier maché, a sheet of glass larger than the sheet to be sensitized, and a squeegee. The solution to be about an inch deep in the dish, and the tissue to be *immersed* in the solution. If air bells form they are to be brushed away at once. The solution should be of moderate temperature, not over 60 deg. Fahr.; the colder the solution the longer the time of immersion, four or five minutes may be taken as an average time. After this time the tissue is laid face down on the glass plate, and the back squeegeed to remove surface moisture. The tissue is then removed from the glass, and dried in the form of a bow, face outward and upward, in a place absolutely free from noxious fumes, as of combustion of gas. The tissue is "insensitive" while wet, but is better dried in non-actinic light. When a brown discoloration is seen in the sensitizing solution it should be rejected.

Tissue, immediately after it is dry, prints somewhat slowly with strong contrast. As the tissue is kept after sensitizing it prints more and more quickly, giving even increasing "softness" till at last it passes into a state of fog and insolubility. If the tissue be kept dry it ought to remain workable for seven or ten days after being sensitized, and a large proportion of ammonia in the sensitizing bath conduces to this quality of keeping.

Mr. H. J. Burton has suggested an excellent method of sensitizing carbon tissue. He lays the tissue flat on clean blotting paper and sponges on to the *back* a very strong sensitizing solution.

Potassic Bichromate	4 ounces
Liq. Amm. fort	1 ounce
Water	20 ounces.

Mix the ammonia and the water, grind up the bichromate and dissolve in the mixture. The tissue by this process may be used much sooner, in hotter weather without fear of solution of the gelatine, and the face of the tissue is kept cleaner.

Before printing, a "safe edge" must be put round the negative, or, more accurately, round the edges of the sheet of tissue, though the safe edge is usually attached to the negative. Black varnish may be painted round the edges of the negative with a brush tied along a slip of wood, the wood acting as a guide along the edges of the negative; or a mask or yellow paper may be used, absolute opacity of the safe edge is not desirable. If the safe edge is omitted and the extremities of the tissue left unprotected, mischief will surely happen later.

The progress of printing cannot be gauged in the usual way, for no visible image is produced by light alone. We have therefore to judge the time necessary by comparison with some sensitive substance yielding a visible image by light action. Sensitized albumen paper is commonly used in an "actinometer." An actinometer containing a piece of sensitized albumenized paper is exposed to the light along with and beside the carbon tissue, and a proportion between the sensitiveness of the albumen paper and the tissue being established, nothing remains but to make allowance for the quality of the negative being printed on the tissue.

There are two types of actinometer, in one the sensitive paper is exposed uncovered to light, and close to the sensitive paper is a painted standard color similar to the color taken by a piece of sensitized albumen paper on exposure to light. When the exposed paper takes the color represented by the paint "one tint" is registered, a fresh white piece of paper exposed for the "second tint," and so on. This actinometer requires pretty constant watching. The other type consists of a small printing frame in which the sensitized paper is covered with a scale of squares of varying opacity. No. 1 square being the least opaque. The "Warnerke Sensitometer Screen" is an illustration of this principle. In this case the sensitive paper is exposed beneath the whole scale, and one figure becomes legible after the other; when, for instance, No. 4 is legible "4 tints" are said to be registered. As both of these sensitometers or actinometers are exposed alongside of the carbon tissue, it is evident that when once the proper exposure for any negative has been determined with either of these instruments, the same number

of tints will always prove right for that negative, time and quality of light being *per se* matters of indifference. The proper number of "tints" for each negative, being once found. should be marked on the negative to save future trouble, Practised carbon printers can judge of the exposure necessary for each negative without using actinometers. Any number of negatives whose required "tints" are known can be printed at one time, provided that an actinometer is exposed at the same time as the tissue, for when the actinometer marks (say) "3 tints" all the negatives marked "3" are removed from the printing light. Carbon tissue prints on an average from 50 to 25 per cent. more quickly than albumenized paper.

If a carbon print after exposure be kept in the dark for a time, the effect on the print is the same as if a longer exposure had been given. This action has been called the "continuating action," and is directly proportionate to the amount of moisture reaching or present in the tissue. To some authorities it is a question whether this continuating action is not identical with the stages of insolubility reached by tissue never exposed to light. As the quantity of moisture in the air is constantly varying, it would be next to impossible to judge of the time for which a print might be kept after exposure, but luckily, in development we have ample power to correct any slight error in judgment as to exposure. Some authorities assert that tissue prints best perfectly dry; others prefer a slightly damp state. Testing these opinions, we found it impossible to judge between them, except that we noticed the effect of continuating action in the damp tissue; and it must be noted that this action begins with the *exposure* of the tissue.

Development consists simply of solution of the gelatine not affected by light, and hot water is the solvent; but certain considerations must not be overlooked. As the pigment is very dark, and the film pretty thick, it is certain that the part of the film next the paper is quite soluble, not having been acted upon by light. Therefore we have to dissolve the lower stratum of gelatine and remove the paper from the back. To do this we have to attach the tissue by its face to a support, rigid or flexible, and when the paper backing is removed we

have evidently a "reversed" picture. This fact entails the operation known as "double transfer," unless in the first instance the negative was "reversed."

We shall begin by outlining the process of producing a positive by "single transfer," using, suppositiously, an opal plate for the final support of the picture. The apparatus required will be a dish as before, a squeegee, and a plate of opal. The opal is laid in the dish and covered with cold water to the depth of about two inches; the exposed sheet of tissue is immersed in the water. At first the tissue will curl up, but after a short time will uncurl and lie flat. As soon as it is flat it is brought face to face with the opal, and the two raised together from the water and laid down or a table, tissue uppermost. A piece of rubber or American cloth is laid on the tissue, the squeegee applied, the cloth removed, and a piece of blotting-paper put in place of the cloth; a flat board is laid on the top, and a weight on the board. If several sheets of tissue are to be developed, they go through this process one after another till all are piled one over the other, and the board and weight over all. Development must not be attempted with any tissue till it has been at least ten minutes under the weight—fifteen minutes will be safer. The dish is now filled with water at about 100 deg. Fahr., and the plates bearing the tissue put in altogether, or one by one. Baths are made with grooves, so that several plates can be developed at once. Presently the colored pigment will be seen to ooze out at the edge of the paper, if a "safe edge" was not omitted, and a short time later the paper will leave the plate at the corners. The paper may be then removed carefully with the hand. After this the plate is bathed with hot water till the mass of dirty black pigment is entirely removed from all but the image, a transformation both surprising, to the beginner, and pleasant. It is not advisable to raise the temperature of the water much above 100 or 110 deg. Fahr.

Under-exposure will show itself in over-solubility of the gelatine; the half-tones of the image will be washed right away and even the shadows will suffer. If anything at all can save an under-exposed print, reduction of the temperature to about

80 deg. will save it, but the better plan is to try again, giving more exposure a "tint" or two more.

Over-exposure will show itself by insolubility of the gelatine; the high-lights will persistently retain a dirty color, the shadows will appear simply a black mass. If prolonged development and persevering laving on of the water fail to complete the development, the temperature of the water may be raised till uncomfortable to the hand. Failing this, ammonia may be added to the water as a last resource; but the best plan is to make another exposure of several "tints" less, or to keep the tissue a shorter time after exposure.

When development is complete and the picture appears as is required, the image-bearing plate is washed in cold water, soaked in a four per cent. solution of potash alum, washed again, and dried. We have now produced a print by the single transfer process; it is on opal glass, and probably reversed; but instead of opal we might have used a glass plate or a piece of prepared paper, and in place of an ordinary negative we might have used one originally "reversed" by means of a prism, or reversal of the plate in the dark-slide.

But supposing our aim is to get a non-reversed print from an ordinary negative, all we have to do is to attach to our reversed positive a piece of paper and detach the positive in adhesion to the paper from the opal. This would be a "double transfer" process.

The double transfer process may be said to consist in transferring the image first to a temporary support, whereon it is developed, thereafter to its permanent support.

As temporary support we may use a prepared paper sold under the name of "flexible support," being coated with some highly polished and impervious substance which is waxed. The following will answer for the waxing solution:

Yellow resin	5 drams
Beeswax	3 drams
Turpentine	1 pint

(The paper, when first used, does not, as a rule, need to be waxed, as it is sold (by the Autotype Co., at least) ready for use. But if it is to be used over again it must be re-waxed.)

If a high gloss is required on the finished print, a plate of glass must be cleaned, rubbed with French chalk (or talc), collodionized, washed, etc., as on page 106.

A *grained* surface is obtained by using, as temporary support, a sheet of grained zinc, waxed as above. In any case, the first transfer is made exactly as already described, operations being the same up to the washing after alum; the washed film is not dried, but is brought into contact with a sheet of so-called "double transfer paper," or "permanent support." This is paper coated with gelatine and barium sulphate, to which alum is sometimes added. It is better, however, to omit the alum, as the Autotype Co. now do, and to bathe the unalumed paper in:

Potash alum	¾ of an ounce
Water	1 pint

A piece of permanent support for each print is immersed in this about the same time as the development of the print begins. This support is squeegeed in the usual way to the developed image, and the whole is allowed to dry, after which a knife point is inserted under one corner of the print and the print will readily leave the temporary support, which, if "flexible support," needs only re-waxing to be ready for use again. For obtaining the highest gloss a sheet of opal, collodionized as above, may be used, this enables the progress of development to be well watched.

To make lantern-slides by the single transfer carbon process, a tissue containing a large amount of coloring matter should be used; such a tissue is prepared by the Autotype Co. for the purpose. The glass used as support should be coated with the following and dried in full daylight.

Gelatine	1 ounce
Potassic bichromate	2 drams
Water	20 ounces

The rest of the process differs in no way from ordinary single transfer.

Defects and Remedies.

Insolubility of tissue, due to drying in warm damp air. Acid sensitizing bath. Too long keeping after sensitizing. Bichromate bath decomposed. Actinic light and "continuative action."

The tissue melts in the sensitizing bath. Too high temperature. Ice the solution or replace twenty-five per cent. of the water with alcohol.

The tissue becomes hard or crackly. Air too dry. Keep in a damp place or add a very little glycerine to sensitizer.

The prints refuse to adhere to temporary support before development. If at edges only, want of "safe edge." If all over, tissue insoluble. Or the tissue allowed to remain too long in the plain water before squeegeeing to temporary support. As the swelling of the gelatine causes the adhesion, it is evident that if the swelling is complete before squeegeeing no adhesion can result. Insufficient time allowed under the weight.

Spots.—Perhaps due to air bells between tissue and support. Air bells are very apt to form in the cold water bath; they must be watched for and removed.

Reticulation, or an appearance of "grain" in the image. A mysterious and not uncommon defect, due probably to incipient insolubility. Remedy: Observe all the precautions suggested for cases where the tissue refuses to adhere to temporary support.

The prints with their final support *refuse to leave the temporary support.* Imperfect waxing or talcing.

CHAPTER XXIX.

POSITIVES AND NEGATIVES BY ENLARGEMENT.

The optics of enlargement may, in principles, be classified under two heads: 1st. The optical principles of *illuminating* the original. 2d. The optical principles of *projecting the image* to form the enlargement.

Under the first heading we have various processes depending upon the radiant, its nature and its position: if the source of light be infinitely distant, practically speaking, as the sun; or if it be practically at a point somewhere near the negative, as a lamp or electric arc; in other words, if the rays be parallel to each other or divergent, then we use a condenser to "condense" or collect rays that would otherwise pass outside of the objective or projecting lens. This condenser is a lens, or combination of lenses, at least as large in area as the negative (or positive) to be enlarged from, and it acts by collecting the rays, passing them all through the negative (or positive) and bringing them to a focus inside the projecting lens. Naturally, therefore, where an originally powerful light is used (as the direct rays of the sun), the light projected through the projecting lens is extremely powerful, and this process of solar enlargement is well suited for enlarging upon surfaces of low sensitiveness, as carbon tissue or albumen paper; and it is equally evident that where we have to use a light of but little actinic power, as a lamp light, a condenser enables us to succeed with an exposure which, even on a moderately sensitive surface, as bromide paper, would otherwise be totally inadequate to produce any developable image at all, not to mention an image on any printing-out material. Enlargement by the solar camera is now so little used by any but great firms requiring it for special purposes, and with the sensitiveness of the films at our

service it is so little necessary, that it is not proposed to go into this subject here at all. Enlargement with a condenser in an optical lantern will be noticed presently. All that requires to be said here is that the diameter of the condenser must be at least equal to, and should be greater than, the diagonal of the original plate or part of the plate to be enlarged, and that the front focus of the condenser should fall within the projecting lens. To illustrate this we give a diagram, Fig. 25. Here *A*

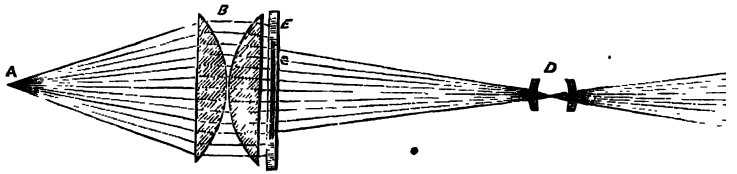

Fig. 25.

is the radiant; *B*, the condenser; *C*, the negative held in a frame *E*; *D* is the objective or projecting lens, in this case a photographic lens. To get the greatest benefit from *B* the relative distances of *A B* and *D* must be such that the focus of *B* falls within *D*. The larger the condenser the more light it will collect and concentrate, so the exposure varies inversely as the area of the condenser.*

Enlarging without a condenser by reflected or diffused light.—When daylight is used with such a printing surface as bromide paper or wet collodion, the exposure required is not unreasonably long; and this system will probably commend itself as, on the whole, the most simple and satisfactory process for obtaining either an enlarged negative for contact printing, or a direct positive enlargement. If the original is a negative we can only produce a direct positive; but if we have previously produced a positive from our original negative, and enlarge that positive, we shall get an enlarged negative, which can be printed by contact in the usual way. A positive made for the latter purpose should be full of detail and almost what might be called slightly fogged in the high lights. A positive

* It will be noticed that the condenser in this cut is capable of illuminating a larger negative than C.

resembling a good lantern-slide is not so suitable for this purpose as one resembling many of the lantern-slides often seen exhibited.

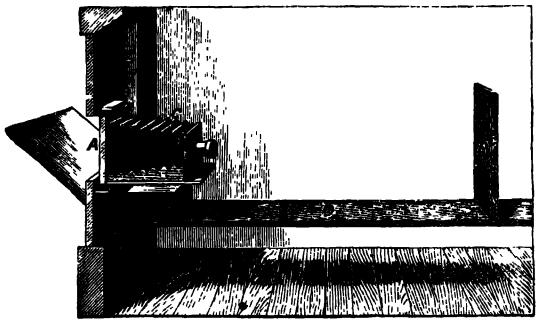

FIG. 26.

We here figure an arrangement for daylight enlarging, so simple that any intelligent reader will understand it, and so easily made that with the help of a carpenter anyone can construct a similar one in a few hours, except, perhaps, the camera, which, however, may be of the simplest construction.

The cut (Fig. 26) is taken from the "Practical Guide to Photographic and Photo Mechanical Printing Processes," by one of the writers, and we are indebted to Messrs. Marion & Co. for the block. The design, though exceedingly simple, suffices to show the general arrangement of parts; greater elegance and convenience may be obtained by the addition of several movements, sufficiently evident. The negative to be enlarged from is placed in the back of the camera *C*, which is fixed to an aperture in a wall preferably facing the north, *D* is a long base-board, along which slides the easel *E*, to which is pinned the sensitive material, if paper, or on which is fixed, in any suitable way, the sensitive surface if glass. The easel *E* may have its centre cut out, and a piece of ground-glass may be fixed in a rebate, and the focusing done from behind. *F* is a reflector, and may be a board covered with some matt white substance, as blotting paper, but shiny papers should be avoided. *F* should be considerably larger than the plate being enlarged from, and *F* is to be so arranged that the plate view from inside is evenly illuminated all over.

As to the lens used for projection, though any lens, however short its focus, may be used with a condenser, the same does not hold good with a reflector. In the latter case the lens should be of sufficient focus, *at least*, to have produced the original negative at full aperture. A half-plate negative cannot in this way be enlarged with a 4-inch lens; and even if a 7½-inch lens be used, it will probably require a stop to make it cover sharp to the edges. But if the focus of the projection lens be ample, no stop will be required at all, as we have to deal with parallel surfaces.

If a scale of inches be marked on the baseboard of the camera, and also on the long board, *D*, or on the floor in the case of a separate easel, and if the table of enlargements found at the end of this book be consulted, the relative positions of the various parts can be very easily regulated, and the focus almost precisely found without examination. Suppose, for instance, it is desired to enlarge a quarter-plate negative to a whole-plate positive, with a lens of 6 inches focus. Consulting the table, we find in the proper square under "4 times" $\frac{30}{7.5}$. We, therefore, at once place the centre of our lens 7½ inches from the negative, and our easel 30 inches from the lens. We then arrange our picture suitably on a piece of plain white paper attached to the easel, raising or lowering our camera front or our easel as desired.

An even less costly arrangement for enlarging very small negatives, as quarter-plates, to moderate sizes, as 10x12 (provided the worker has two cameras, a small one and a large one, with sufficient stretch), is figured 27 on page 173. For enlarging, of course, this arrangement is reversed—that is to say, the small camera is placed next the light. With this arrangement good enlargements may be produced without any specially adapted apartment.

It is impossible to lay lown rules for exposure, so many different cases have to be met. The light varies, our sensitive materials vary, our negatives vary; but supposing there was no variation in these, and supposing the same lens with the same aperture to be invariably used, we can then give at least one rule which will be of service.

Exposure varies directly as "times" of enlargement. Example: To enlarge a quarter-plate negative to whole plate (4 areas) the required exposure is found to be ten minutes. To enlarge the same negative under the same conditions of light, lens, sensitive surface, etc., to 13x17 inches (16 areas), the exposure required would be forty minutes: 4:16 :: 10:40.

During exposure no actinic light must enter the apartment, and during focusing it is well to allow no light to enter the room at all, actinic or otherwise, except what passes through the negative and the projection lens. While the sensitive material is being put in position after focusing, the lens is to be capped, and the room may be illuminated by non-actinic light, for which provision was made. While the exposure is going on a great deal can be done in the way of "dodging." Vignettes of any shape can be produced by cutting an aperture of the required shape in a piece of cardboard or wood, and holding the mask so made between the lens and the sensitive surface, moving the mask constantly to and from the sensitive material. As the image is plainly seen projected on the sensitive surface, this operation is one of perfect simplicity. In like manner any part of the image that prints too dark can be shaded during part of the exposure. But in any case the mask should be kept on the move, else hard lines will result on the print.

Whatever be the sensitive surface used, bromide paper, wet collodion, etc., development is conducted as already laid down under the several headings. When large sheets of paper are used special developing dishes may be required; dishes for larger sheets may be made with plate glass bottoms and varnished wooden sides.

Enlarging by the Optical Lantern with (1) an oil lamp (2) oxyhydrogen lime light. This is perhaps the favorite process with amateurs, and it is certainly a convenient and simple process for enlarging small originals. But the condenser must be of diameter equal to, and ought to be of diameter slightly greater, than the diagonal of the part to be enlarged. In the next place the lantern nozzle should be so constructed as to allow the objective to be racked to at least twice its own

focal length from the negative. The sensitive material is fixed in front of the objective, which may be a portrait lens, and the whole system from light to sensitive material should be axially centered, and the paper or glass parallel with the negative. No light must stray from the lantern so as to affect the sensitive material, so it is usual to inclose the ordinary optical lantern in a larger box, the nozzle only protruding through a hole for the purpose. Lanterns are, however, made specially for the purpose of enlarging, and usually are well adapted for that purpose.

When the oxyhydrogen light is used the area of incandescence of the lime, being but small, is easily placed in the focus of the condenser, but where a lamp with several wicks is used there is apt to be a considerable loss of light. To obviate this loss of light Mr. J. Traill Taylor suggests the use of a simple supplementary lens placed between the light and the condenser, and, like most of that gentleman's optical suggestions, this one is very valuable.

The same rules hold good for this process of enlarging, with regard to exposure, as for the daylight process. The effect of the condenser in shortening the exposure may seem astonishing to the beginner, who is ignorant of the optics of the matter. Vignetting and other "dodging" are quite as easy with artificial light as daylight.

We have seen and used an arrangement for enlarging still more simple and less costly than those described above. No condenser was used, but the artificial light was diffused over the original by means of a sheet of finely ground-glass placed between the light and the negative,and about one and one-half inch behind the original. By this process a much larger negative may be enlarged by artificial light, but the exposure is very long, and the rules for choice of projection lens are the same as for daylight enlarging with a reflector, that is to say the projecting lens must be of long focus. If the original be unusually large, as 8x10 or 10x12 inches, several lights will be required to illuminate the original evenly, the only alternative—removing the light to a considerable distance from the ground-glass—entailing an inconvenient duration of exposure.

Collodion Transfers are produced by coating a talced sheet of glass with iodized collodion, sensitizing, developing, fixing and washing in the usual way, provision being made for securing pleasing tones. The film is then placed in contact with a sheet of paper such as "Carbon Double Transfer" (see page 162), squeegeeing the paper to the film, drying, and stripping from the glass. These transfers are usually enlargements, which is our reason for mentioning them here.

CHAPTER XXX.

LANTERN SLIDES.

PHOTOGRAPHY, perhaps, reaches its climax of beauty and utility in a good lantern-slide shown on a good screen with a good light. The size of the view so shown is not *per se* the chief advantage, but it enables a number of people to see in company which is always pleasing to the majority of people. The optical lantern is valuable both to art and science, for while *pictures* may be shown on a scale more dignified and more worthy of their merits, scientific *facts* may be demonstrated in a manner precluding mistake, and with a weight of evidence precluding unbelief. But while a good lantern-slide is a thing of beauty and of utility, a bad one is a horror which we too often see in public exhibitions, not to mention private ones.

The worker must first learn the characteristics of a good slide, and they are not learned without considerable study. A slide may be a very pretty, little, positive transparency, and yet totally useless as a lantern-slide. A slide must have, first, absolute clearness in the highest lights; second, transparent shadows. If either of these points is transgressed the slide is useless, to start with. But besides the *highest* lights no other part must be absolutely clear. The *midsummer snow scenes*, so frequently seen—and frequently applauded by an ignorant public—are the results of neglect of this rule. These "hard" slides are usually the result of either hard negatives or under-exposure of the slides, necessitating forced development. A slide must have plenty of half tone, but not too much. The commonest type, perhaps, of bad slides, is that where we see nothing but half tone, to put it mildly, or nothing but incipient fog, to put it plainly. Beginners with gelatine bromide

for lantern-slides are very apt to produce these foggy lides; nothing can be uglier, unless it is the snow scenes already alluded to. A slide must have:

1. Clear highest lights.
2. Half-tone in secondary lights.
3. Detail in the shadows.
4. A pleasing "tone" or color.

The processes commonly used for producing lantern-slides are: Wet collodion, dry collodion, gelatine chloride, gelatine bromide. In point of exposure the gelatine bromide is by far the quickest of these processes, gelatine chloride is so insensitive that practically it is only used for making "slides by contact." When the negative is just about the size required for a lantern-slide (three and a quarter inches square), contact printing is resorted to, a sensitive plate taking the place of a piece of paper used for ordinary printing in a frame; care must be taken not to scratch the negative nor the sensitive plate when bringing the two together. When the negative is larger than the standard slide size, the slide has to be made by "reduction in the camera." The process of reduction is simply making a copy on glass of the negative by transmitted light; the copy will, of course, be a positive.

Mechanical Arrangements for Reducing.—As a matter of practice any means whereby a copy may be made of the negative as above, the copy being of the proper size, will answer for making a slide by reduction, but it is found better to take precautions to prevent any light, other than what passes through the negative, from reaching the copying lens. Many costly and intricate arrangements have been devised for the mechanical part of the process, but we shall confine ourselves to the description of one apparatus which everyone is likely to have, or can at least get with very little trouble. The first requisite is the camera in which the original negative was taken, a wet-plate slide fitting that camera, or a double slide with the internal partition removed. The other requisite is also a camera, this time a quarter plate camera of the simplest description, no motion but a rack and pinion for focusing being required, fitted with a short focus lens, such as a rectilinear stereo lens.

The front, or part of the front of the larger camera is removed, and the small camera is fitted to the front of the larger camera, with the small lens protruding into the larger camera. We figure (Fig. 27) our own arrangement, as fitted up by our-

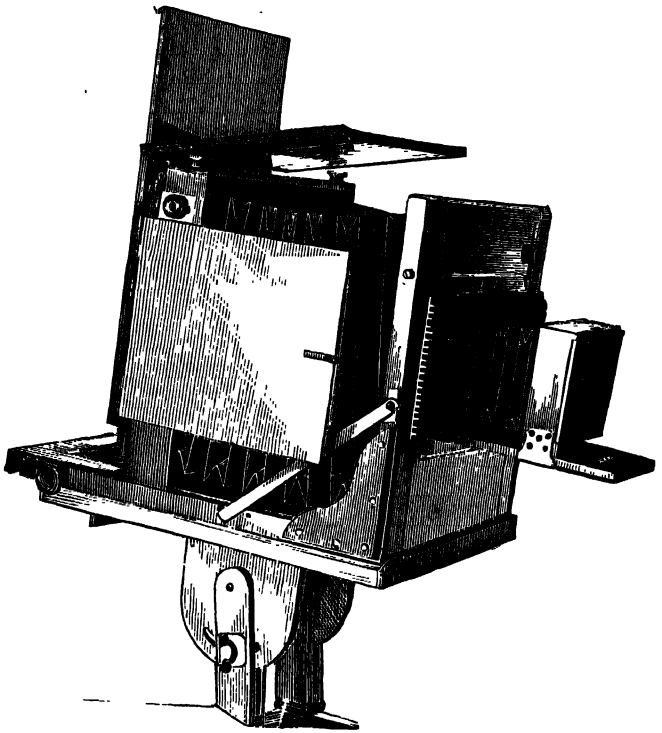

FIG. 27.

selves, and we have never yet found circumstances which this did not suit. The lens should be of very short focus, not over four inches or four and a half inches focus, and must be rectilinear. The negative to be copied goes into the dark-slide of the larger camera, the sensitive plate goes into the dark-slide of the small camera. The back of the larger camera may be pointed towards the sky. and a sheet of finely-ground glass placed about one or two inches behind the negative; *i. e.*, between the negative and the light; or a sheet of white paper

large enough to illuminate by reflection, the whole negative may be inclined at 45 deg. between the light and the negative. The amount of reduction is regulated by the focusing arrangement of the larger camera, different parts of the negative may be selected for copying by the front motions of the larger camera, and focusing is performed on the ground-glass of the small camera, preferably with a Ramsden eyepiece.

The exposure with ground-glass behind the negative may vary at $\frac{1}{15}$:

With Gelatine Bromide lantern plates, from five to one hundred and twenty seconds.

With Wet Collodion, from thirty seconds to ten minutes.

With Dry Collodion, from three minutes to two hours.

We have, of course, gone beyond these limits in both directions; the table is given merely suggestively.

Even gelatine chloride plates may be used for reduction in the camera, the exposure being very long if the negatives are of average density. Gelatine chloride emulsion may be made more sensitive by cooking, but, as a rule, there is great danger of fogginess from this proceeding.

Gelatine chloride emulsion for lantern-slides and transparent positives. Plates prepared with this emulsion are usually exposed in contact with the negative, for a few seconds, to daylight. The negative is placed in a printing frame face upwards, and the chloride plate carefully laid on the negative film to film. Mr. A. Cowan, of London, has favored the public with some very fine developing formulæ for such plates, and by the use of his varied proportions and ingredients he produced a large range of tones on his plates.

Iron protosulphate	140 grains
Sulphuric acid	1 minim
Water	1 ounce

Add one part of this to three parts of any of the following, No. 1 giving cold tones, No. 3 almost crimson. No. 3 requires much more exposure than No. 2, and No. 2 more than No. 1.

1. Potassic citrate	136 grains
Potassic oxalate	44 grains
Hot water	1 ounce

2. Citric Acid.....120 grains
Ammonia carbonate..... 88 grains
Cold water..... 1 ounce

3. Citric acid.....180 grains
Ammonia carbonate..... 60 grains
Water..... 1 ounce

The following, due to Mr. B. J. Edwards, gives good tones.

a. Neutral potassic oxalate..... 2 ounces
Ammonium chloride.....40 grains
Distilled water.....20 ounces

b. Iron protosulphate..... 4 drams
Citric acid..... 2 drams
Potash alum..... 2 drams
Water.....20 ounces

Mix *a* and *b* in equal proportions.

Chloride plates should develop pretty rapidly; if the image appears to develop *too* rapidly add a few drops of a ten per cent. solution of common salt. Fix in hypo, and after washing clear with a saturated solution of potash alum, acidulated with sulphuric acid.

Glass and opal plates coated with this emulsion yield beautiful positives, when printed in contact and treated as above.

Lantern-Slides by Dry Collodion Processes.—Supposing plates to be coated with collodio-bromide emulsion prepared as given on page 46, *et seq.*, we proceed to give instructions how these plates may best be used for lantern-slides, and we may say that it is extremely doubtful whether for really good lantern-slides with clear lights, transparent shadows, and, above all, warm tones, this process can be surpassed.

To insure the warm tones on which we so much insist, the use of ammonia is contraindicated, and the carbonates coupled with a long exposure will be found best. The formulæ we give are due mostly to Mr. W. Brooks, of Reigate, who prepares emulsion, and with it slides not easily equaled.

PYRO SOLUTION.

Pyrogallol..... 96 grains
Alcohol..... 1 ounce

ALKALINE SOLUTIONS.

1.	Saturated solution of ammonia carbonate	4 ounces
	Potassic bromide	60 grains
	Sodic acetate	120 grains
	Water	8 ounces
2.	Potassic carbonate	360 grains
	Potassic bromide	60 grains
	Sodic acetate	120 grains
	Water	12 ounces
3.	Potassic carbonate	300 grains
	Potassic bicarbonate	150 grains
	Potassic bromide	60 grains
	Sodic acetate	120 grains
	Water	12 ounces

No. 1 requires the longest exposure, and gives the warmest tones; the ammonium carbonate must be fresh and pure, and for saturation should be left several days in water, getting an occasional shaking. After this some of the crystals must be left at the bottom of the bottle. No. 2 is a more powerful alkaline solution than No. 1, and requires much less exposure. The tones given by No. 2 are not so good as those of No. 1. Nos. 1 and 3, mixed in equal quantities, give a grand chestnut tone with a moderate exposure.

After exposure the plate is flowed in yellow light with a mixture of methylated spirits and water in equal parts. This is allowed to act on the film for about a minute, and is then washed off. The plate may either be immersed in the developer in a dish or held in the hand by a pneumatic holder, and the developer flowed over it. Development is not so quick as with a gelatine plate; the image appears faint at first, with details, perhaps, all over, and density is gained very gradually.

The developer consists of

Pyro solution, as above	20 minims
One of the alkaline solutions, or a mixture of two of them	2 drams
Water	2 drams

The developer must not be poured off and on at first, but as details and density increase pouring off and on may be resorted

to as a local intensification. Development to full density may occupy five or six minutes, and the plate is then to be washed and fixed with hypo, or, preferably, potassic cyanide, 20 grains; water, 1 ounce. Re-development may be resorted to with pyro and silver, as follows, but we do not like it, as the shadows are apt to get blocked up.

Re-developer (which may also be used later as an intensifier):

Pyrogallol	30 grains
Citric acid	30 grains
Alum	30 grains
Water	15 ounces

Flow a sufficient quantity of this over the plate, then return it to the cup to which meantime have been added, for every two drams of the pyro and acid solution, two or three drops of a twenty-grain solution of silver nitrate. This is to be poured on and off the plate, but the instant any cloudiness appears the solution must be rejected and a fresh quantity made if necessary.

To get various fine tones more nearly approaching the blues the plate may be toned with:

Platinic chloride	1 grain
Nitric acid	1 minim
Water	3 ounces

The plate may be removed when a warm brown tone is arrived at, or at any other desired stage, but to produce a very fine engraving black tone the plate may be left in the platinum solution till the image is almost gone, or very gray; it is then to be washed and intensified with the pyro intensifier given. Though we do not like re-development, we recommend intensification after fixing by this acid-alum-pyro solution, which is due to Mr. Brooks, and gives very fine tones indeed.

Any slight veil or fog on a collodion positive may be removed by flowing over it several times a strong colored solution of iodine made by adding water to the "tincture." Silver iodide is formed, and cyanide solution, as for fixing, will clear the plate at once.

Collodion slides and positives for window decoration, which

may be made equally with slides by the above process, should be varnished with a clear white varnish (see formulæ at the end).

Wet collodion for lantern-slides. We have pointed out in Chapter VI. a suitable method of making slides by this process. The platinum toning bath may be used as above, or the following, due to Mr. T. N. Armstrong, an amateur of Glasgow:

Palladium chloride	15 grains
Water	15 ounces

For each ounce of water required to cover the slide in a dish take one dram of the above. Leave the slide in this till the tone has reached the back of the film, as seen through the glass plate. If any dense parts refuse to tone, pour the solution on to them several times from a slight height. Eight or ten minutes should suffice to tone a plate by this method, and the tone is not only unique but highly pleasing.

Gelatine Bromide for Lantern-Slides.—In the chapter on slow gelatine-bromide emulsion will be found directions for making an emulsion eminently suitable for the purpose of lantern-slide preparation. We may say that the "slower" the emulsion the more likely it will be to give good slides in the beginner's hands. The gelatine-bromide plates usually put on the market for this purpose are, in our opinion, too rapid and too liable in unskilled hands to give foggy slides, which of all kind of slides are the worst and the commonest. The exposure, whether by contact, or in the camera, must be such that no forcing, or abnormal quantity of alkali, is required in development; further we need not go.

For development the ferrous oxalate may be used, keeping the proportion of iron low, and using a proportion of soluble bromide (say half a grain to each ounce of a developer consisting of potassic oxalate solution, as given elsewhere (page 92), six parts, iron solution one part).

Mr. Carbutt, U. S. A., gives a formula which will be found to work well with many plates.

a.	Potassic oxalate	8 ounces
	Water	30 ounces
	Citric acid	60 grains
	Citrate of ammonia solution	2 ounces

b. Ferrous sulphate..... 4 ounces
Water..... 32 ounces
Sulphuric acid..... 8 minims

The citrate of ammonia solution is:

Dissolve citric acid..... 1 ounce
Water..... 5 ounces

Add liquor ammonia till neutral, make up to eight ounces. The developer consists of

a..... 2 ounces
b..... 1 ounce
10 per cent solution of potassic bromide..... 5 minims

Mr. Edward's hydrochinon developer acts well. It will be found quoted on page 145.

Where a *warm tone* is required, undoubtedly the best developer is alkaline pyrogallol. But sodic sulphite must not form an ingredient of the alkaline pyro developer, we have never liked the tone peculiar to that salt, and we have never yet been able entirely to prevent the peculiar tone given by that salt from appearing in our slides. Very much superior, in our estimation, for this purpose, if for no other, is the potassic bisulphite, which first caught our attention in a formula promulgated by Messrs. Mawsan and Swan, of Newcastle. The salt was, in this formula, called "meta-bisulphite;" we have never yet met a satisfactory account of this name, and we find ordinary potassic bisulphite precisely the same in action as in appearance and odor. We shall, however, give Messrs. Mawsan and Swan's own formula, leaving the reader to use the "meta," if he can get it, or omit the "meta," if it is not forthcoming.

a. Pyrogallol..... 40 grains
Potassic meta-bisulphite ..... 120 grains
Water..... 20 ounces

b. Liquor ammonia fort..... 2½ drams
Ammonium bromide..... 40 grains
Water..... 10 ounces

To develop mix *a* and *b* in equal proportions. With any of these developers the image should begin to appear after the

plate has been in the solution about forty-five seconds or a minute. There should be no rushing up of details or density. Very pretty little glass dishes may be obtained for developing slides; they must be kept scrupulously clean; a stain that would never be noticed on a negative, may be ruin to so delicate a picture as a lantern-slide should be.

We give one more pyro developer, which may be called a standard developer; it works well with every good plate we have yet met.

a. Solution of pyro, preserved with citric acid, 20 grains to each ounce..... 10 per cent
b. Ammonia..... 10 per cent
c. Bromide (amm. or pot.)..... 10 per cent

DEVELOPER.

a.....20 minims
b.....20 to 25 minims
c.....20 minims
Water..... 1 ounce

Fixing is done with

Sodic hyposulphite.....1 part
Water. .....5 parts

After fixing, a scum is frequently noticed on slides. Strong solution of alum, acidified with sulphuric acid, poured on and off, will almost always remove the scum. Mr. Edwards recommends the addition of ferrous sulphate to the alum and acid. If the plate, after fixing, be not washed, but merely rinsed under the tap, a fine warm tone may be produced by pouring on a solution of the following nature:

Alum (potash) concentrated solution, containing citric acid to saturation ..... 1 ounce
Iron protosulphate, saturated..... ½ ounce

The warm tone produced may be suspected of fugitiveness, but we find it permanent.

Eastman's transferotype process yields fine slides. (See page 147.) The development is conducted as usual, preferably with ferrous oxalate, and the finished paper film is squeegeed to a piece of glass of the required size, and scrupulously clean.

If the plates are just 3¼ inches square, the prints should, before being squeegeed, be trimmed slightly smaller, as the edges of the paper must not overlap the glass. After stripping, which must not be attempted until at least half an hour has elapsed after squeegeeing, the plate is cleared with alum and acid, washed and dried. All slides should be varnished with clear or "crystal" varnish.

To Mount Lantern-Slides.—Articles required: Masks of variously shaped apertures; "strips" to gum round edges; clean and thin glasses 3¼ inches square. The cover-glasses should be free from imperfections, as bubbles. The shape of the mask apertures is a matter not sufficiently attended to. Mr. J. W. Champney contributed to a New York society some remarks which deserve attention. The masks must be opaque. A very good paper for the purpose is white on one side and black on the other, the white side being utilized for writing the names of the subjects. "Strips" are sold ready-gummed. As a rule, these cannot be trusted to stick long, and the safer plan is to get plain strips of "needle-paper" about 14 inches long, and at the time of use to cover each strip with thin glue, to which is added a small quantity of oil of lavender, a hint for which we have to thank the illustrious Mr. George Washington Wilson, of Aberdeen.[1]

The slide being finally mounted requires some mark, so that the lantern operator may know at a glance which way to put it into the lantern. Lay the slide down on the table *as the view appeared in nature*; and at each of the *two top corners* place a small disc of gummed paper, white on a black mask, and *vice versa.*

CHAPTER XXXI.

RESIDUES.

AMATEURS, who find their hobby somewhat expensive, and professionals, whose yearly returns are not as large as might be desired, will do well to preserve carefully all material containing noble metals in any shape. A very small percentage of the silver originally used in the preparation of sensitive substances is present in the finished negative or print. We have seen it stated that a print on albumenized paper contains only about 3 per cent. of the silver originally present in it. We do not guarantee the accuracy of this estimate, but it is probably not very far wide of the mark.

The following should always be carefully preserved: 1st. All paper containing or bearing silver salts, as trimmings of untoned albumenized paper, bromide and chloride papers, filter papers used for silver solutions. 2d. Water wherein prints containing free silver nitrate have been washed. 3d. Old toning baths. 4th. Old fixing baths. 5th. Waste emulsions of any kind.

1. *Paper Residues.* After a considerable quantity of waste paper has been collected, it should be burned completely to fine ashes. An ordinary stove or grate will answer for burning, provided the draught do not carry away the very light ashes.

2. *Washing Waters.* The first two waters used for washing sensitized albumenized paper should be put into a reservoir with a tap about four to six inches from the bottom. When the vessel is pretty full, hydrochloric acid may be used to acidify the residue, and the silver may be thrown down as chloride by the addition of a quantity of concentrated solution of sodic chloride—common salt. Hydrochloric acid may be used to

throw down all the silver, but we prefer the salt. If too much salt be added, the chloride will be re-dissolved. When the chloride is all down, the supernatant liquid is drawn off by the tap, or siphoned off, or even baled off. The chloride is collected, washed in water, dried, and added to the paper ashes.

3. *Old Toning Baths.* In a toning bath the gold may be inert as a toning substance but can be saved. The bottle containing a toning bath often becomes encrusted with a deposit of gold; this may be dissolved by *aqua regia* and added to the bulk of old baths. The bulk being acidified with sulphuric acid, a saturated solution of ferrous sulphate is added till no more gold is precipitated. The precipitate is collected, washed, dried, and may either be added to Nos. 1 and 2, or kept separate.

4. *Old Fixing Baths* are usually the most valuable of all residues. Every plate, whether exposed or gone wrong before, during or after exposure, should be "fixed." The used fixing baths are to be preserved in a vessel similar to that used for No. 2. The solution should be acidified with sulphuric acid, and precipitation of the silver effected by the addition of a strong solution of potassic sulphide, "liver of sulphur." This, however, must not be done in the operating, nor, indeed, in any inhabited room; but in the open air, for the odor is both unpleasant and unwholesome. As an alternative, strips of zinc or copper may be suspended in the old hypo solution, when the silver will be precipitated on the strips or on the vessel. When the precipitation is complete, the deposit is collected, washed, dried, and kept separate from other residues.

5. *Old Emulsions*, if of collodion, may be poured out to set in a flat dish, allowed to desiccate, lifted or scraped from the dish, and added to the paper ashes, or the chlorides. If of gelatine, they should be treated in one of the following ways: Add to the waste emulsion, in a large iron pot, five times its weight of caustic alkali and boil for half an hour. The boiling will be very furious at first, but will subside after a little. Or several times its bulk of sulphuric acid may be added to the emulsion and the whole boiled for a few minutes. In each case the gelatine will be deprived of its setting power

or viscous quality, and the silver in whatever state it is will settle to the bottom and can be separated by decantation from the liquid. It may then be washed and added to the chlorides.

Platinum residues are very valuable and may be saved thus: All waste paper should be passed through the developing solution. Old potassic oxalate developing solutions are collected and boiled with one-fourth of their volume of ferrous sulphate. The platinum separates and can be collected on a filter.

We do not advise the reader to fuse his own residues as a matter of business, for a professional refiner will get much more noble metal out of them than the photographer is likely to do. As an interesting experiment, however, the following may be tried. Take the paper ash and the chlorides, with which may be included the gold, dry all thoroughly and mix with a *flux* consisting of four times the weight of the chlorides of a mixture in equal parts of the carbonates of soda and potash. Mix thoroughly and put into a crucible, subjecting it to white heat till the contents of the crucible are perfectly liquid. Then either pour out on to a cold stone floor, or allow to cool and break the crucible. In one case a bar, in the other a button of silver, will be found. If gold is present a refiner will allow for it.

FORMULÆ RECOMMENDED.

Varnish for gelatine negatives ("British Journal Almanac.")

Best Orange Shellac	1½ ounce
Methylated alcohol	1 pint

Keep in a warm place till dissolved, then add a large teaspoonful of whiting or prepared chalk; set aside to clear; decant.

Plate to be heated before and after application.

GROUND GLASS OR "MATT" VARNISH.

Sandarac	90 grains
Mastic	20 grains
Ether	2 ounces
Benzole	½ to 1½ ounces

More benzole added finer the matt obtained.

This varnish to be applied cold.

GELATINE BROMIDE PROCESSES—DEVELOPERS.

EDWARD'S GLYCERINE DEVELOPER.

a.	Pyro	1 ounce
	Glycerine	1 ounce
	Methyl alcohol	6 ounces

Mix spirits and glycerine, then add pyro.

a. One part of this to fifteen of water.

b.	Potassic bromide	60 grains
	Liq. Amm. .880	1 ounce
	Glycerine	1 ounce
	Water	6 ounces

b. One part of this to fifteen of water.

Developer: Equal parts of the above, *a* and *b*.

MR. WOLLASTON'S MODIFICATION OF THE EASTMAN DEVELOPER FOR PAPER NEGATIVES

a.	Sodic sulphite pure	8 ounces
	Hot distilled water	40 ounces

Cool to 60 deg. Fahr. Make just acid with citric acid. Pour on to one ounce of pyro.

b. Sodic carb..... 4 ounces
Potassic carb..... 1 ounce
Distilled water..... 40 ounces

Equal parts of *a* and *b*.

A Simple Developer for Gelatine Bromide.

a. Pyro..... 40 grains

Added to,

Water..... 10 ounces

In which is dissolved

Citric acid..... 10 grains

b. Liq. Amm. .880..... 1 dram
Amm. brom..... 25 grains
Water..... 10 ounces

Equal parts of *a* and *b*.

Hydrochinon Developer.

a. Hydrochinon..... 20 grains
Water..... 10 ounces
Sodic sulphite..... 10 grains

Dissolved together first.

b. Carbonates according to Wollaston above or to formula in text.

Clearing Solutions for Gelatine Bromide Plates.

Mr. Edwards'.

Alum..... 1 ounce
Citric acid..... 1 ounce
Sulphate of iron..... 3 ounces
Water..... 20 ounces

Another:

Alum..... 3 ounces
Hydrochloric acid..... ½ ounce
Water..... 20 ounces

Intensifying Solutions for Gelatine Plates.

a. Mercuric chloride..... 1 part
Ammonic chloride..... 1 part
Water..... 20 parts

Bleach thoroughly, wash thoroughly, then pour on

b. Liquid ammonia	1 part
Water	20 parts

Or,

Sodic hyposulphite	1 part
Water	10 parts

Or,

Sodic sulphite	1 part
Water	5 parts

Uranium Intensifier.

a. Uranium nitrate in water	1 per cent.
b. Potassic ferricyanide in water	2 per cent.

Flood the plate with *a*, then mix in *b*.

Toning Baths.

Black Tones (Mr. Schölzig).

Sodic tungstate	30 grains
Boiling water	3 ounces

Dissolve, then add

Gold chloride	1 grain
Water to	8 ounces

Phosphate Bath.

Sodic phosphate	30 grains
Gold chloride	1 grain
Water	8 ounces

Does not keep well.

TABLE OF ATOMIC AND MOLECULAR WEIGHTS OF THE ELEMENTS.

(Derived from Professor F. W. Clarke's figures.)

Names and Symbols.	Weights.	Apprx Wghts.	Names and Symbols.	Weights.	Apprx Wghts.
Aluminum, Al....	27.0090	27.	Nickel, Ni...	57.9280	57.9
Antimony, Sb....	119.9550	120.	Niobium, Nb.....	93.8120	93.8
Arsenic, As	74.9180	74.9	Nitrogen, N.....	14.0210	14.
Barium, Ba.....	136.7630	136.8	Osmium, Os.....	198.4940	198.5
Bismuth, Bi.....	207.5230	207.5	Oxygen, O.....	15.9633	16.
Boron, Bo.....	10.9410	10.9	Palladium, Pd ...	105.7370	105.7
Bromine, Br	79.7680	79.8	Phosphorous, P...	30.9580	31.
Cadmium, Cd....	111.8350	111.8	Platinum, Pt.....	194.4150	194.4
Cæsium, Cs.....	132.5830	132.6	Potassium, K....	39.0190	39.
Calcium, Ca.....	39.9900	40.	Rhodium, Rh.....	104.0550	104.1
Carbon, C.....	11.9736	12.	Rubidium, Rb....	85.2510	85.3
Cerium, Ce.....	140.4240	140.4	Ruthenium, Ru..	104.2170	104.2
Chlorine, Cl.....	35.3700	35.4	Scandium, Sc....	43.9800	44.
Chromium, Cr....	52.0090	52.	Selenium, Se.....	78.7970	78.8
Cobalt, Co.....	58.8870	58.9	Silicon, Si.....	28.1950	28.2
Copper, Cu.....	63.1730	63.2	Silver, Ag.....	107.6750	107.7
Didymium, D....	144.5730	144.6	Sodium, Na.....	22.9980	23.
Erbium, E.....	165.8910	165.9	Strontium, Sr . ..	87.3740	87.4
Fluorine, Fl.....	18.9840	19.	Sulphur, S	31.9840	32.
Gallium, Ga.....	68.8540	68.9	Tantalum, Ta....	182.1440	182.1
Glucinum, G.....	9.0850	9.1	Tellurium, Te....	127.9600	128.
Gold, Au...	196.1550	196.2	Thallium, Tl.....	203.7150	203.7
Hydrogen, H.....	1.0000	1.	Thorium, Th.....	233.4140	233.4
Indium, In.....	113.3980	113.4	Tin, Sn.....	117.6980	117.7
Iodine, I.....	126.5570	126 6	*Titanium, Ti....	47.0997	48.
Iridium, Ir.....	192.6510	192.7	Tungsten, W.....	183.6100	183 6
Iron, Fe.....	55.9130	55.9	Uranium, U	238.4820	238.5
Lanthanum La....	138.5260	138.5	Vanadium, Va....	51.2560	51.3
Lead, Pb.....	206.4710	206.5	Ytterbium, Yb ..	172.7610	172.8
Lithium, Li.....	7.0073	7.	Yttrium, Y.....	89.8160	89.8
Magnesium, Mg..	23.9590	24.	Zinc, Zn.....	64.9045	64.9
Manganese, Mn...	53.9060	53.9	Zirconium, Zr....	89.3670	89.4
Mercury, Hg.....	199 7120	199.7			
Molybdenum, Mo	95.5270	95.5			

* Thorpe, T. E., *Chemical News*, 48; 251.

DR. JANEWAY'S TABLE OF THE SOLUBILITY OF PHOTOGRAPHIC CHEMICALS.

MADE FOR THE SOCIETY OF AMATEUR PHOTOGRAPHERS OF NEW YORK.

Abbreviations.—ins., insoluble; sp. s., sparingly soluble; m. s., moderately soluble; v. s., very soluble; dec., decomposed.

CHEMICALS.	WATER.		COLD ALCOHOL.
	59° F.	212° F.	
One part is soluble in	Parts.	Parts.	
Acid, Citric	0.75	.6	v. s.
Gallic	100	3	m. s.
Oxalic	8	1	v. s.
Pyrogallic	3.5	v. s.	v. s.
Tannic	6	v. s.	v. s.
Alum	10.5	v. s.	ins.
Chrome	10	dec.	ins.
Ammonium, Nitrate	0.5	v. s.	v. s.
Chloride	3	v. s.	sp. s.
Carbonate	4	dec.	m. s.
Sulphocyanate	v. s.	v. s.	v. s.
Bromide	1.5	0.7	sp. s.
Iodide	1	0.5	m. s.
Baryta, Nitrate	8	3	
Cadmium, Bromide	v. s.	v. s.	m. s.
Iodide	v. s.	v. s.	v. s.
Copper, Acetate	15	5	sp. s.
Sulphate	2.6	0.5	ins.
Gold, Chloride	v. s.	v. s.	v. s.
Gold and Sodium Chloride	v. s.	v. s.	m. s.
Iron, Perchloride	v. s.	v. s.	v. s.
Protosulphate	1.8	0.3	ins.
and Ammonia sulphate	8	0.8	ins.
Iodide (Ferrous)	v. s.	v. s.	sp. s.
Iodine	7000		m. s.
Kaolin	ins.	ins.	ins.
Lead, Acetate	1.8	0.5	m. s.
Chloride	v. sp.	33	ins.
Nitrate	2	0.8	ins.
Lithium, Bromide	v. s.	v. s.	m. s.
Iodide	v. s.	v. s.	m. s.
Magnesia, Nitrate	v. s.	v. s.	m. s.
Mercury, Bichloride	16	2	v. s.
Cyanide	12.8	3	ins.
Potassium, Acetate	0.4	v. s.	v. s.

CHEMICALS.	WATER.		COLD ALCOHOL.
	59° F.	212° F.	
One part is soluble in	Parts.	Parts.	
Potassium, Bicarbonate	3.2	dec.	ins.
Bichromate	10	1.5	ins.
Bromide	1.6	1	sp. s.
Carbonate	1	0.7	ins.
Cyanide	2	1	m. s.
Ferricyanide	3.8	2	ins.
Ferrocyanide	4	2	ins.
Nitrate	4	0.4	ins.
Iodide	0.8	0.5	m. s.
Oxalate	3	v. s.	ins.
Permanganate	20	3	ins.
Sulphate	9	4	ins.
Sulphite	4	5	sp. s.
Sulphuret	2	1	sp. s.
Silver, Nitrate	0.8	0.4	m. s.
Oxide	v. sp. s.	v. sp. s.	ins.
Sodium, Acetate	3	1	m. s.
Bromide	1.2	0.5	m. s.
Bicarbonate	12	dec.	ins.
Carbonate	1.6	0.25	ins.
Citrate	v. s.	v. s.	sp. s.
Hyposulphite	1	v. s.	ins.
Iodide	0.6	0.3	m. s.
Nitrate	1.3	0.6	sp. s.
Phosphate	6	2	ins.
Pyrophosphate	12	1.1	ins.
Sulphite	4	0.9	sp. s.
Sulphate	2.8	0.4	ins.
Tungstate	4.0	2.0	ins.
Strontia, Chloride	1.88	v. s.	sp. s.
Uranium, Nitrate	v. s.	v. s.	m. s.
Zinc, Iodide	v. s.	v. s.	m. s.
Bromide	v. s.	v. s.	m. s.
Chloride	0.33	v. s.	v. s.

METRIC SYSTEM OF WEIGHTS AND MEASURES.

MEASURES OF LENGTH.

Denominations and Values.		Equivalents in Use.	
Myriameter	10,000 meters.	6.2137	miles.
Kilometer	1,000 meters.	.62137	mile, or 3,280 ft. 10 ins.
Hectometer	100 meters.	328.	feet and 1 inch.
Dekameter	10 meters.	393.7	inches.
Meter	1 meter.	39.37	inches.
Decimeter	1-10th of a meter.	3.937	inches.
Centimeter	1-100th of a meter.	.3937	inch.
Millimeter	1-1000th of a meter.	.0394	inch.

MEASURES OF SURFACE.

Denominations and Values.		Equivalents in Use.	
Hectare	10,000 square meters.	2.471	acres.
Are	100 square meters.	119.6	square yards.
Centare	1 square meter.	1,550.	square inches.

MEASURES OF VOLUME.

Denominations and Values.			Equivalents in Use.	
Names.	No. of Liters.	Cubic Measures.	Dry Measure.	Wine Measure.
Kiloliter or stere	1,000	1 cubic meter.	1.308 cubic yards.	264.17 gallons.
Hectoliter	100	1-10th cubic meter.	2 bu. and 3.35 pecks.	26.417 gallons.
Dekaliter	10	10 cubic decimeters.	9.08 quarts.	2.6417 gallons.
Liter	1	1 cubic decimeter.	.908 quart.	1.0567 quarts.
Deciliter	1-10	1-10th cubic decimeter.	6.1022 cubic inches.	.845 gill.
Centiliter	1-100	10 cubic centimeters.	.6102 cubic inch.	.338 fluid oz.
Milliliter	1-1000	1 cubic centimeter.	.061 cubic inch.	.27 fl. drm.

WEIGHTS.

Denominations and Values.			Equivalents in Use.
Names.	Number of Grams.	Weight of Volume of Water at its Maximum Density.	Avoirdupois Weight.
Millier or Tonneau	1,000,000	1 cubic meter.	2204.6 pounds.
Quintal	100,000	1 hectoliter.	220.46 pounds.
Myriagram	10,000	10 liters.	22.046 pounds.
Kilogram or Kilo	1,000	1 liter.	2.2046 pounds.
Hectogram	100	1 deciliter.	3.5274 ounces.
Dekagram	10	10 cubic centimeters.	.3527 ounce.
Gram	1	1 cubic centimeter.	15.432 grains.
Decigram	1-10	1-10th of a cubic centimeter.	1.5432 grain.
Centigram	1-100	10 cubic millimeters.	.1543 grain.
Milligram	1-1000	1 cubic millimeter.	.0154 grain.

For measuring surfaces, the square dekameter is used under the term of ARE: the hectare, or 100 ares, is equal to about two acres. *The unit of capacity* is the cubic decimeter or LITER, and the series of measures is formed in the same way as in the case of the table of lengths. The cubic meter is the unit of measure for solid bodies, and is termed STERE. *The unit of weight* is the GRAMME, which is the weight of one cubic centimeter of pure water weighed in a vacuum at the temperature of 4 deg. Cent. or 39.2 deg. Fahr., which is about its temperature of maximum density. In practice, the term cubic centimeter, abbreviated c.c., is used instead of milliliter, and cubic meter instead of kiloliter.

UNITED STATES WEIGHTS AND MEASURES.

ACCORDING TO EXISTING STANDARDS.

LINEAL.

	Inches.	Feet.	Yards.	Rods.	Furlong.
12 inches = 1 foot.	12				
3 feet = 1 yard.	36 =	3			
5.5 yards = rod.	198 =	16.5 =	5.5		
40 rods = 1 furlong.	7,920 =	660 =	220 =	40	
8 furlongs = 1 mile.	63,360 =	5,280 =	1,760 =	320 =	8

SURFACE—LAND.

	Ft.	Yds.	Rods.	Roods.	Acres.
144 sq. ins. = 1 sq. ft.					
9 sq. ft. = 1 sq. yd.	9 =	1			
30.25 sq.yds.= 1 sq.rod.	272.25 =	30.25 =	1		
40 sq.rods.= 1 sq.rood.	10,890 =	1,210 =	40 =	1	
4 sq. roods = 1 acre.	43,560 =	4,840 =	160 =	4 =	1
640 acres 1 sq. mile.	27,878,400 =	3,097,600 =	102,400 =	2,560 =	640

VOLUME—LIQUID.

	Gills.	Pints.	Cub. In.
4 gills = 1 pint.			
2 pints = 1 quart.	8		
4 quarts = 1 gallon.	32 =	8 =	231

FLUID.

Gallon.	Pints.	Ounces.	Drams.	Minims.	Cubic Centimetres.
1 =	8 =	128 =	1,024 =	61,440 =	3,785.441
	1 =	16 =	128 =	7,680 =	473.180
		1 =	8 =	480 =	29.574
			1 =	60 =	3.697

16 ounces, or a pint, sometimes called a pound.

TROY WEIGHT.

Pound.	Ounces.	Pennyweights.	Grains.	Grams.
1 =	12 =	240 =	5,760 =	373.25
	1 =	20 =	480 =	31.10
		1 =	24 =	1.55

APOTHECARIES' WEIGHT.

lb. Pound.	℥ Ounces.	ʒ Drams.	℈ Scruples.	gr. Grains.	Grams.
1 =	12 =	96 =	288 =	5,760 =	373.25
	1 =	8 =	24 =	480 =	31.10
		1 =	3 =	60 =	3.89
			1 =	20 =	1.30
				1 =	.06
				15½. =	1.00

The pound, ounce, and grain are the same as in Troy weight.

AVOIRDUPOIS WEIGHT.

Pound.	Ounces.	Drams.	Grains (Troy).	Grams.
1 =	16 =	256 =	7,000 =	453.60
	1 =	16 =	437.5 =	28.35
		1 =	27.34 =	1.77

TABLES FOR THE CONVERSION OF GRAMS (OR CUBIC CENTIMETRES) INTO OUNCES AND GRAINS.

CONVERSION OF GRAMS INTO GRAINS.

Grams.	Grains.
1	15.43
2	30.86
3	46.29
4	61.73
5	77.16
6	92.59
7	108.03
8	123.46
9	138.89

CONVERSION OF GRAINS INTO GRAMS.

Grains.	Grams.
1	.0648
2	.1296
3	.1944
4	.2592
5	.3240
6	.3888
7	.4536
8	.5184
9	.5832

CONVERSION OF GRAMS INTO TROY OUNCES.

Grams.	Troy Ounces.
1	.03215
2	.06430
3	.09645
4	.12860
5	.16075
6	.19290
7	.22505
8	.25720
9	.28935

CONVERSION OF GRAMS INTO AVOIRDUPOIS OUNCES.

Grams.	Avoirdupois Ounces.
1	.03527
2	.07054
3	.10581
4	.14108
5	.17635
6	.21162
7	.24689
8	.28216
9	.31743

The above tables render the conversion of the weights in question a matter of great ease, the error introduced in the last decimal place being trivial.

The use of the tables will be best illustrated by an example. Supposing that it is desired to find the equivalent in grains of 324.51 grams, we proceed by breaking up this number into the following series of constituent parts, and finding the grain-equivalent of each part from the table:

Portions of original number.	Equivalents in grains.
300.00	4630.
20.00	308.6
4.00	61.73
.50	7.716
.01	.1543
	5008.2003

The required quantity is 5008.2 grains. The numbers taken from the table will, in most cases, require a change as regards the position of the decimal point; thus, to find the value of 300 grams, one refers to the table, and finds 46.30 given as the equivalent, and a mere shifting of the decimal point two places towards the right multiplies this by 100, or gives the required number. In a similar manner, by shifting the decimal place of 30.86 one place to the right we obtain the value in grains of 20 grams; while the number 61.7 is taken from the table without alteration as the equivalent of 4 grams. For .50 the table number must have its point shifted on to the left, making it 7.716 instead of 77.16; and finally, the value of .01 is obtained by shifting the point of 15.43 two places to the left.

The above operations are, in actual practice, performed with considerable speed, the required equivalents being written down one after the other on a scrap of paper, and then added up.

TABLE SHOWING THE COMPARISON OF THE READINGS OF THERMOMETERS.

CELSIUS, OR CENTIGRADE (C). RÉAUMUR (R). FAHRENHEIT (F).

C.	R.	F.	C.	R.	F.
—30	—24.0	—22.0	23	18.4	73.4
—25	—20.0	—13.0	24	19.2	75.2
—20	—16.0	— 4.0	25	20.0	77.0
—15	—12.0	+ 5 0	26	20.8	78.8
—10	— 8.0	14.0	27	21.6	80.6
— 5	— 4.0	23.0	28	22.4	82 4
— 4	— 3.2	24.8	29	23 2	84.2
— 3	— 2.4	26.6	30	24.0	86.0
— 2	— 1.6	28.4	31	24.8	87.8
— 1	— 0.8	30.2	32	25.6	89.6
			33	26.4	91.4
Freezing point of water.			34	27.2	93.2
			35	28.0	95.0
0	0.0	32.0	36	28.8	96.8
1	0.8	33.8	37	29.6	98.6
2	1.6	35.6	38	30.4	100.4
3	2.4	37.4	39	31.2	102.2
4	3.2	39.2	40	32.0	104.0
5	4.0	41.0	41	32.8	105.8
6	4.8	42.8	42	33.6	107.6
7	5.6	44.6	43	34.4	109.4
8	6.4	46.4	44	35.2	111.2
9	7.2	48.2	45	36.0	113.0
10	8.0	50.0	50	40.0	122.0
11	8.8	51 8	55	44.0	131.0
12	9.6	53.6	60	48.0	140.0
13	10.4	55.4	65	52.0	149.0
14	11.2	57.2	70	56.0	158.0
15	12.0	59.0	75	60.0	167.0
16	12.8	60.8	80	64 0	176.0
17	13.6	62.6	85	68.0	185.0
18	14.4	64.4	90	72.0	194.0
19	15.2	66.2	95	76.0	203.0
20	16.0	68.0	100	80.0	212.0
21	16.8	69.8			
22	17.6	71.6	Boiling point of water.		

Readings on one scale can be changed into another by the following formulæ, in which $t°$ indicates degrees of temperature:

Réau. to Fahr	Cent. to Fahr.	Fahr. to Cent.
$\left(\frac{9}{4}t° \text{ R}\right) + 32° = t° \text{ F}$	$\frac{9}{5}t° \text{ C} + 32° = t° \text{ F}$	$\frac{5}{9}\left(t° \text{ F} - 32°\right) = t° \text{ C}$
Réau. to Cent.	**Cent. to Réau.**	**Fahr. to Réau.**
$\frac{5}{4}t° \text{ R} = t° \text{ C}$	$\frac{4}{5}t° \text{ C} = t° \text{ R}$	$\frac{4}{9}\left(t° \text{ F} - 32\right) = t° \text{ R}$

ACKLAND'S TABLES FOR THE SIMPLIFICATION OF EMULSION CALCULATIONS.

No. 1.

	Equivalent weights.	Weight of $AgNO_3$ required to convert one grain of soluble haloid.	Weight of soluble haloid required to convert one grain $AgNO_3$.	Weight of silver haloid produced by one grain of soluble haloid.	Weight of soluble haloid required to produce one grain of silver haloid.	Weight of silver haloid produced from one grain $AgNO_3$.
Ammonium bromide.....	98	1.734	.576	1.918	.521	
Potassium "	119.1	1.427	.700	1.578	.633	
Sodium "	103	1.650	.606	1.825	.548	
Cadmium " com...	172	.988	1.012	1.093	.915	1.106
" " anh....	136	1.25	.800	1.382	.723	
Zinc "	112.1	1.509	.663	1.670	.600	
Ammonium chloride.....	53.5	3.177	.315	2.682	.373	.844
Sodium "	58.5	2.906	.344	2.453	.408	
Ammonium iodide.....	145	1.172	.853	1.620	.617	
Potassium "	166.1	1.023	.977	1.415	.707	1.382
Sodium "	150	1.133	.882	1.566	.638	
Cadmium "	183	.929	1.076	1.284	.778	

Table No. 1 presents the actual weights of haloid or silver, as the case may be, required to convert or combine with one grain of another.

In order to make (say) ten ounces of emulsion by a new formula, which, for the sake of showing the working of the table, we will write down as follows:

Bromide of potassium..... .....150 grains.
Iodide of potassium..... 10 "
Chloride of ammonium..... 10 "
Gelatine ....200 "

we want to know how much silver nitrate should be employed in sensitizing this mixture. For this purpose we use the first column, in which we find against each haloid the exact quantity of silver nitrate required to fully decompose one grain. Taking, then, the figures we find in column No. 1 against the three salts in the above formula, and multiplying them by the number of grains of each used, we have the following sum:

Potassium bromide..... .....150 × 1.432 = 214 } Weight
" iodide..... ..... 10 × 1.023 = 10.23 } silver nitrate
Chloride of ammonium..... ..... 10 × 3.177 = 31.77 } required.

or the total quantity of silver nitrate required for full conversion, 256.00 grains.

"UNIFORM SYSTEM" NUMBERS FOR STOPS FROM $f\,1$ TO $f\,100$.

In the following table Mr. S. A. Warburton has calculated the exposure necessary with every stop from $f\,1$ to $f\,100$ compared with the unit stop of the "uniform system" of the Photographic Society of Great Britain. The figures which are underlined show in the first column what $f\,a$ must be in order to increase the exposure in geometrical ratio from $f\,4$, the intermediate numbers showing the uniform system number for any other aperture.

f	U. S. No.	f	U. S. No.	f	U. S. No.
1	1/16	15	14.06	58	210.25
1¼	.097	16	16	59	217.56
1.414	⅛	17	18.06	60	225.00
1½	.140	18	20.25	61	232.56
1¾	.191	19	22.56	62	240.25
2	¼	20	25.00	63	248.06
2¼	.316	21	27.56	64	256
2½	.390	22	30.25	65	264.06
2.828	½	22.62	32	66	272.25
2¾	.472	23	33.06	67	280.56
3	.562	24	36.00	68	289.00
3¼	.660	25	39.06	69	297.56
3½	.765	26	42.25	70	306.25
3¾	.878	27	45.56	71	315.06
4	1.00	28	49.00	72	324.00
4¼	1.12	29	52.56	73	333.06
4½	1.26	30	56.25	74	342.25
4¾	1.41	31	60.06	75	351.56
5	1.56	32	64	76	361.00
5¼	1.72	33	68.06	77	370.56
5½	1.89	34	72.25	78	380.25
5.656	2	35	76.56	79	390.06
5¾	2.06	36	81.00	80	400.00
6	2.25	37	85.56	81	410.06
6¼	2.44	38	90.25	82	420.25
6½	2.64	39	95.06	83	430.56
6¾	2.84	40	100.00	84	440.00
7	3.06	41	105.06	85	451.56
7¼	3.28	42	110.25	86	462.25
7½	3.51	43	115.56	87	473.06
7¾	3.75	44	121.00	88	484.00
8	4	45	126.56	89	495.06
8¼	4.25	45.25	128	90	506.25
8½	4.51	46	132.25	90.50	512
8¾	4.78	47	138.06	91	517.56
9	5.06	48	144.00	92	529.00
9¼	5.34	49	150.06	93	540.56
9½	5.64	50	156.25	94	552.25
9¾	5.94	51	162.56	95	564.06
10	6.25	52	169.00	96	576.00
11	7.56	53	175.56	97	588.06
11.31	8	54	182.25	98	600.25
12	9.00	55	189.06	99	612.56
13	10.56	56	196.00	100	625.00
14	12.25	57	203.06		

TABLE FOR ENLARGEMENT AND REDUCTION

COMPUTED FOR CENTIMETERS OR INCHES.

Equivalent Focus of the Lens.	DISTANCES OF THE OBJECT AND THE GROUND GLASS SCREEN FROM THE CENTER OF THE OBJECTIVE.																								
	1 *t.*	2 *t.*	3 *t.*	4 *t.*	5 *t.*	6 *t.*	7 *t.*	8 *t.*	9 *t.*	10 *t.*	11 *t.*	12 *t.*	13 *t.*	14 *t.*	15 *t.*	16 *t.*	17 *t.*	18 *t.*	19 *t.*	20 *t.*	21 *t.*	22 *t.*	23 *t.*	24 *t.*	25 *t.*
5..	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130
	10	7.5	6.7	6.2	6	5.8	5.7	5.6	5.6	5.5	5.4	5.4	5.4	5.4	5.3	5.3	5.3	5.3	5.3	5.3	5.2	5.2	5.2	5.2	5.2
6..	12	18	24	30	36	42	48	54	60	66	72	78	84	90	92	102	108	114	120	126	132	138	144	150	156
	12	9	8	7.5	7.2	7	6.9	6.8	6.7	6.6	6.5	6.5	6.4	6.4	6.4	6.4	6.4	6.3	6.3	6.3	6.3	6.3	6.3	6.3	6.2
7..	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140	147	154	161	168	175	182
	14	10.5	9.3	8.8	8.4	8.2	8	7.9	7.8	7.7	7.6	7.6	7.5	7.5	7.5	7.4	7.4	7.4	7.4	7.4	7.3	7.3	7.3	7.3	7.3
8..	16	24	32	40	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160	168	176	184	192	200	208
	16	12	10.7	10	9.6	9.3	9.1	9	8.8	8.8	8.7	8.7	8.6	8.6	8.5	8.5	8.5	8.4	8.4	8.4	8.4	8.4	8.3	8.3	8.3
9..	18	27	36	45	54	63	72	81	90	99	108	117	126	135	144	153	162	171	180	189	198	207	216	225	234
	18	13.5	12	11.3	10.8	10.5	10.3	10.1	9.9	9.9	9.8	9.8	9.7	9.6	9.6	9.6	9.5	9.5	9.5	9.5	9.4	9.4	9.4	9.4	9.4
10..	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250	260
	20	15	13.3	12.5	12	11.7	11.4	11.3	11.1	11	10.9	10.8	10.8	10.7	10.7	10.6	10.6	10.6	10.5	10.5	10.5	10.5	10.4	10.4	10.4
11..	22	33	44	55	66	77	88	99	110	121	132	143	154	165	176	187	198	209	220	231	242	253	264	275	286
	22	16.5	14.7	13.8	13.2	12.8	12.6	12.4	12.2	12.1	12	11.9	11.8	11.8	11.7	11.7	11.6	11.6	11.6	11.6	11.5	11.5	11.5	11.5	11.4
12..	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288	300	312
	24	18	16	15	14.4	14	13.7	13.5	13.3	13.2	13.1	13	12.9	12.9	12.8	12.7	12.7	12.7	12.6	12.6	12.6	12.5	12.5	12.5	12.5
13..	26	39	52	65	78	91	104	117	130	143	156	169	182	195	208	221	234	247	260	273	286	299	312	325	338
	26	19.5	17.3	16.3	15.6	15.1	14.9	14.6	14.4	14.3	14.2	14.1	14	13.9	13.9	13.8	13.8	13.7	13.7	13 7	13.6	13.6	13.6	13.5	13.5
14..	28	42	56	70	84	98	112	126	140	154	168	182	196	210	224	238	252	266	280	294	308	322	336	350	364
	28	21	18.7	17.5	16.8	16.3	16	15.8	15.6	15.4	15.3	15.2	15.1	15	14.9	14,9	14.8	14.8	14.7	14.7	14.7	14.6	14.6	14.6	14.6
15..	30	45	60	75	90	105	120	135	150	165	180	195	210	225	240	255	270	285	300	315	330	345	360	375	390
	30	22.5	20	18 8	18	17.5	17.1	16.9	16.7	16.5	16.4	16.3	16.2	16.1	16	15.9	15.9	15.8	15.8	15.8	15,7	15,7	15.7	15.6	15.6

16..	32	48	64	80	96	112	128	144	160	176	192	208	224	240	256	272	288	304	320	336	352	368	384	400	416
	32	24	21.3	20	19.2	18.7	18.3	18	17.8	17.6	17.5	17.3	17.2	17.1	17.1	16.9	16.9	16.9	16.8	16.8	16.8	16.7	16.7	16.7	16.6
17..	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340	357	374	391	408	425	442
	34	25.5	22.7	21.3	20.4	19.8	19.4	19.1	18.9	18.7	18.5	18.4	18.3	18.2	18.1	18.1	18	17.9	17.9	17.9	17.8	17.8	17.7	17.7	17.7
18..	36	54	72	90	108	126	144	162	180	198	216	234	252	270	288	306	324	342	360	378	396	414	432	450	468
	36	27	24	22.5	21.6	21	20.6	20.3	20	19.8	19.6	19.5	19.4	19.3	19.2	19.1	19.1	19	18.9	18.9	18.9	18.8	18.8	18.8	18.7
19..	38	57	76	95	114	133	152	171	190	209	228	247	266	285	304	323	342	361	380	399	418	437	456	475	494
	38	28.5	25.3	23.8	22.8	22.2	21.7	21.4	21.1	20.9	20.7	20.6	20.5	20.4	20.3	20.2	20.1	20.1	20	20	19.9	19.8	19.8	19.8	19.8
20..	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340	360	380	400	420	440	460	480	500	520
	40	30	26.6	25	24	23.3	22.9	22.5	22.2	22	21.8	21.7	21.5	21.4	21.3	21.3	21.2	21.2	21.1	21	21	20.9	20.9	20.8	20.8
21..	42	63	84	105	126	147	168	189	210	231	252	273	294	315	336	357	378	399	420	441	462	483	504	525	546
	42	31.5	28	26.3	25.2	24.5	24	23.7	23.3	23.1	22.9	22.8	22.6	22.5	22.4	22.3	22.2	22.2	22.1	22.1	22	21.9	21.9	21.9	21.8
22..	44	66	88	110	132	154	176	198	220	242	264	286	308	330	352	374	396	418	440	462	484	506	528	550	572
	44	33	29.3	27.5	26.4	25.7	25.1	24.8	24.4	24.2	24	23.8	23.7	23.6	23.5	23.4	23.2	23.2	23.2	23.1	23	23	23	22.9	22.1
23..	46	69	92	115	138	161	184	207	230	253	276	299	322	345	368	391	414	437	460	483	506	529	552	575	598
	46	34.5	30.7	28.8	27.6	26.7	26.3	25.9	25.6	25.3	25.1	24.9	24.8	24.6	24.5	24.4	24.3	24.3	24.2	24.2	24.1	24	24	24	23 9
24..	48	72	96	120	144	168	192	216	240	264	288	312	336	360	384	408	432	456	480	504	528	552	576	600	624
	48	36	32	30	28.8	28	27.4	27	26.7	26.4	26.2	26	25.8	25.7	25.6	25.5	25.4	25.3	25.3	25.2	25.1	25.1	25	25	25
25..	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500	525	550	575	600	625	650
	50	37.5	33.3	31.3	30	29.2	28.6	28.1	27.8	27.5	27.3	27.1	26.9	26.8	26.7	26.6	26.5	26.4	26.3	26.3	26.2	26.1	26	26	26

The use of the above table will best be explained by illustrations;

To enlarge six times with a lens of 15 centimeters (or inches) focal length. We find in the table under 6 *t.* and opposite the figures $\frac{105}{17.5}$, hence the object must be 17.5, and the screen 105 centimeters (or inches) from the centre of the lens.

To reduce eight times with a lens of 19 centimeters (or inches) focus, the object must be 171 and the screen 21.4 centimeters (or inches) from centre of lens.

The table can be formulated thus: Where p = focal length of lens, a = distance from ground-glass to centre of lens and b = distance from object to centre of lens, then $\frac{1}{a} + \frac{1}{b} = \frac{1}{p}$

PROF. BURTON'S TABLE OF COMPARATIVE EXPOSURES.

Apertures Calculated on the Standard System of the Photographic Society.	Sea and Sky.	Open Landscape.	Landscape with heavy foliage in foreground.	Under Trees, up to	Fairly Lighted Interiors.	Badly Lighted Interiors, up to	Portraits in bright diffused Light out of doors.	Portraits in good Studio Light.	Portraits in Ordinary Room.
				mins. secs.	mins. secs.	hrs. mins.		mins. secs.	mins. secs.
No. 1, or $\frac{f}{4}$	$\frac{1}{180}$ sec.	$\frac{1}{30}$ sec.	$\frac{1}{8}$ sec.	0 10	0 10	0 2	$\frac{1}{8}$ sec.	0 1	0 4
No. 2, or $\frac{f}{5.657}$	$\frac{1}{90}$ sec.	$\frac{1}{15}$ sec.	$\frac{1}{4}$ sec.	0 20	0 20	0 4	$\frac{1}{8}$ sec.	0 2	0 8
No. 4, or $\frac{f}{8}$	$\frac{1}{45}$ sec.	$\frac{1}{15}$ sec.	$\frac{1}{2}$ sec.	0 40	0 40	0 8	$\frac{3}{8}$ sec.	0 4	0 16
No. 8, or $\frac{f}{11.314}$	$\frac{1}{20}$ sec.	$\frac{1}{6}$ sec.	1 sec.	1 20	1 20	0 16	$1\frac{1}{8}$ sec.	0 8	0 32
No. 16, or $\frac{f}{16}$	$\frac{1}{10}$ sec.	$\frac{1}{3}$ sec.	2 secs.	2 40	2 40	0 32	$2\frac{2}{3}$ secs.	0 16	1 4
No. 32, or $\frac{f}{22.627}$	$\frac{1}{5}$ sec.	$\frac{2}{3}$ sec.	4 secs.	5 20	5 20	1 4	$5\frac{1}{3}$ secs.	0 32	2 8
No. 64, or $\frac{f}{32}$	$\frac{2}{5}$ sec.	$1\frac{1}{3}$ sec.	8 secs.	10 40	10 40	2 8	$10\frac{2}{3}$ secs.	1 4	4 16
No. 128, or $\frac{f}{45.255}$	$\frac{4}{5}$ sec.	$2\frac{2}{3}$ secs	16 secs.	21 20	21 20	4 16	21 secs.	2 8	8 32
No. 256, or $\frac{f}{64}$	$1\frac{3}{5}$ sec.	$5\frac{1}{3}$ secs	32 secs.	42 40	42 40	8 32	42 secs.	4 16	17 4

EXTRACTS FROM TABLE DEVELOPING FORMULÆ.

COMPILED BY MESSRS. LYONEL CLARK AND E. FERRERO, OF THE CAMERA CLUB.

The quantities are given in grains and minims per ounce of developer.

PLATES.	Pyro.	Ammonium Bromide.	Potassium Bromide.	Ammonia.	Sodium Carbonate.	Potassium Carbonate.	Ammonium Carbonate.	Sodium Sulphite.	Potassium Meta-bisulphite.
	Grains	Grains	Grains	Minims	Grains	Grains	Grains	Grains	Grains
*Abney and Derby..	2	2 to 4	....	1.60 to 4	....	....	...	....	....
Ditto	3.60	....	....	....	....	22	....	18.80	....
*Academy	2	2	....	4	....	..	....	....	..
Albert...	1.50	0.63	....	3.16	....	....	.. .	....	....
*Beechey (Dry Col.).....	12	...	3	....	....	. .	90	....	....
*Beernaert....	4.78	..	....	. .	16.05	....	....	38.10	. .
*Britannia.....	2	2	....	4	....	....	....	....	....
*Cadett's...	1.50	3	....	6	....	....	....	....	....
Charterhouse.....	1.36	3.40	....	1.36	....	....	....	2.72	....
Cranbourne.....	1.10	....	0.12	2.30	...	....	....	4.40	....
Derwent.....	2.18	....	....	....	14.4	....	....	38.4	....
*Eastman's Paper Negative...	4.50	....	....	....	19	....	....	27	....
*Eastman's Stripping Film....	4.50	....	....	....	19	....	....	27	....
Do. Do.	3.53	....	...	...	12	3	....	21.18	....
Edwards's XL.....	2.10	0.50	....	2	...	...	....	....	....
*England's Instantaneous ...	1.50	....	1	2	....	....	....	....	....
*Ditto, Do.	3.40	....	....	....	....	8.60	...	17	....
*Globe.	2	1	....	4	....	....	....	....	....
*Ilford.....	1.85	2.50	....	4.50	....	....	....	....	....
Keystone.....	2.50	....	....	....	....	6.41	....	10	....
*Lancaster's..... ...	2.40	....	0.82	5	....	....	....	....	....
Ludgate.....	2.14	....	0.23	1.87	....	....	....	....	....
Mawson and Swan's...	1.50	0.75	...	3.75	....	....	....	....	1.50
Do, New Cheap...	1.50	1.50	....	3.75	. .	....	....	....	...
Mawdsley	1.50	....	0.50	3	. .	....	....	....	....

* The above analyses have been submitted to the makers of the plates, and asterisks are affixed to all the formulæ of which approval has been signified.

PERCENTAGE OF REAL AMMONIA IN SOLUTIONS OF DIFFERENT DENSITIES AT 14 DEG. CENTIGRADE.

(CARIUS.)

Specific Gravity.	Percentage Ammonia.	Specific Gravity.	Percentage Ammonia.	Specific Gravity.	Percentage Ammonia.	Specific Gravity.	Percentage Ammonia.
0·8844	35·0	0·9052	26·0	0·9314	18·0	0·9631	9·0
0·8864	34·0	0·9078	25·0	0·9347	17·0	0·9670	8·0
0·8885	33·0	0·9106	24·0	0·9380	16·0	0·9709	7·0
0·8907	32·0	0·9133	23·0	0·9414	15·0	0·9749	6·0
0·8929	31·0	0·9162	22·0	0·9449	14·0	0·9790	5·0
0·8953	30·0	0·9191	21·0	0·9484	13·0	0·9831	4·0
0·8976	29·0	0·9221	20·0	0·9520	12·0	0·9875	3·0
0·9001	28·0	0·9251	19·0	0·9558	11·0	0·9919	2·0
0·9026	27·0	0·9288	18·0	0·9598	10·0	0·9959	1·0

ELSDEN'S TABLE OF POISONS AND ANTIDOTES.

	Poisons.	Remarks.	Characteristic Symptoms.	Antidote.
Caustic Vegetable Alkalies.	Oxalic Acid. including Potassium Oxalate.	1 dram is the smallest fatal dose known.	Hot, burning sensation in throat and stomach; vomiting, cramps, and numbness.	Chalk, whiting or magnesia, suspended in water. Plaster or mortar can be used in emergency.
	Ammonia. Potash. Soda.	Vapor of ammonia may cause inflammation of the lungs.	Swelling of tongue, mouth, and fauces; often followed by stricture of the œsophagus.	Vinegar and water.
Metallic Salts.	Mercuric Chloride.	3 grains the smallest known fatal dose.	Acrid, metallic taste, constriction and burning in throat and stomach, followed by nausea and vomiting.	White and yolk of raw eggs with milk. In emergency, flour paste may be used.
	Acetate of Lead.	The sub-acetate is still more poisonous.	Constriction in the throat and at pit of stomach; crampy pains and stiffness of abdomen; blue line round the gums.	Sulphates of soda or magnesia. Emetic of sulphate of zinc.
	Cyanide of Potassium.	*a*. Taken internally, 3 grs. fatal.	Insensibility, slow, gasping respiration, dilated pupils, and spasmodic closure of the jaws.	No certain remedy; cold affusion over the head and neck most efficacious.
		b. Applied to wounds and abrasures of the skin.	Smarting sensation.	Sulphate of iron should be applied immediately.
	Bichromate of Potassium	*a*. Taken internally.	Irritant pain in stomach, and vomiting.	Emetics and magnesia, or chalk.
		b. Applied to slight abrasions of the skin.	Produces troublesome sores and ulcers.	
	Nitrate of Silver.		Powerful irritant.	Common salt to be given immediately, followed by emetics.
Concentrated Mineral Acids.	Nitric Acid.	2 drams have been fatal. Inhalation of the fumes has also been fatal.	Corrosion of windpipe and violent inflammation.	Bicarbonate of soda, or carbonate of magnesia or chalk, plaster of the apartment beaten up in water.
	Hydrochloric Acid.	½ ounce has caused death.		
	Sulphuric Acid.	1 dram has been fatal.		

Acetic Acid, concentrated, has as powerful an effect as the mineral acids.

Iodine.	Variable in its action; 3 grains have been fatal.	Acrid taste, tightness about the throat, vomiting.	Vomiting should be encouraged, and gruel, arrowroot and starch given freely.
Ether.	When inhaled.	Effects similar to chloroform.	Cold affusion and artificial respiration.
Pyrogallol.	2 grains sufficient to kill a dog.	Resemble phosphorus poisoning.	No certain remedy. Speedy emetic desirable.

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——o FOR 1889 o——

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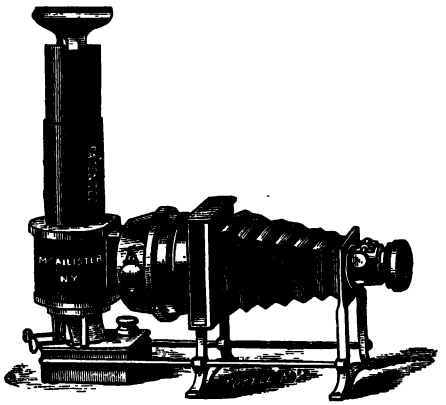

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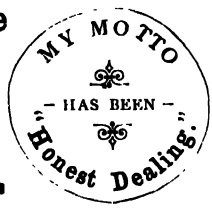

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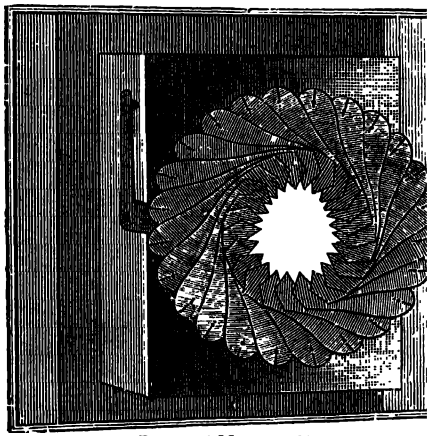

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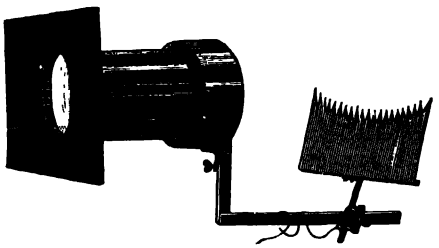

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